TRAINEE WORK

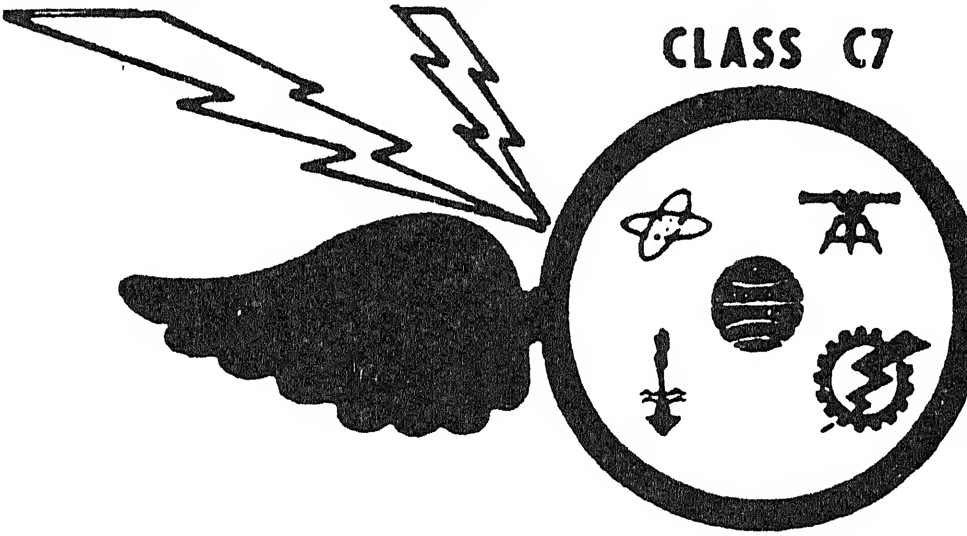
FOR

AVIONICS INTERMEDI

AND

AVIATION ELECTRICIAN'S MATE I

CLASS C7



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UNIT V

AVIONICS INTERMEDIATE COURSE/
AVIATION ELECTRICIANS MATE INTERMEDIATE C
CLASS C7
C-100-2012, C-602-2014
STUDENT WORKBOOK

NO.

TABLE OF CONTENTS

Junction Field-Effect Transistors
Assignment Sheet
Student Activity Guide
Diagram Sheets

Metal-Oxide semiconductor FETs
Assignment Sheet
Student Activity Guide
Diagram Sheets

Special Semiconductor Devices
Assignment Sheet
Student Activity Guide
Job Sheet
Diagram Sheets

Vacuum Tube Amplifiers
Assignment Sheet
Student Activity Guide

Feedback Amplifiers
Assignment Sheet
Student Activity Guide

ASSIGNMENT SHEET 5.1.1A
JUNCTION FIELD-EFFECT TRANSISTORS

JCTION: This assignment will provide activities which directly relate to the learning objectives listed below. If you can accomplish this assignment, you have met the requirements of the learning objectives. It is recommended that you answer these questions with the same materials as those you will have when taking the progress test. In this way, you will be testing yourself.

TOPIC LEARNING OBJECTIVES:

Given a list of statements, select the definition of a Field Effect Transistor (FET).

Given statements describing the difference in current carriers between bipolar and field effect transistors, select the correct statement(s).

Given a list of statements, select the definition of a Junction Field-Effect Transistor (JFET).

Given statements concerning the construction of JFETs, select the correct statement(s).

Given a block diagram of a JFET, label the source, drain, gate and type channel.

Given statements concerning the operation of a JFET, select the correct statement(s).

Given a graph of drain characteristics for a JFET, correctly label drain current (I_D), voltage drain to source(V_{DS}), pinchoff voltage (V_P), breakover voltage (BV_{DGS}), the ohmic region, pinchoff region and the breakdown region.

Given statements concerning the parameters used to analyze JFETs, select the correct statement(s).

Given statements concerning the advantages and disadvantages of JFETs compared to bipolar transistors, select the correct statement(s).

5.1.10 Given statements comparing the three JFET circuit c figurations with each other in the following areas, select the correct statement(s).

A. Relationship between input and output signals

B. Voltage, current and power gains

C. Input and output resistances

5.1.11 Given schematic diagrams for JFET amplifiers, label the elements and list the following:

A. Circuit configuration

B. Type channel

C. Type biasing

STUDY ASSIGNMENT

Read:

1. Boylestad and Nashelsky, Electronic Devices and Circ Theory, 3rd Ed., Prentice-Hall, 1982, Ch. 5, pp 192- Ch. 6, pp 208-217, Ch. 8, pp 296-318.

Complete: Student Activity Guide 5.1.1S

STUDY QUESTIONS: NONE

1. The JFET differs from the bipolar transistor in that it (select the correct statements):

   a. has unipolar majority carriers.
   b. is a voltage controlled device.
   c. utilizes a foward-biased PN junction for control of unipolar carriers.
   d. has high input impedance with forward bias.

2. Match the electrodes of other devices to the JFETs which are similar.

   a. Anode
   b. Base
   c. Emitter
   d. Collector

   a. Gate
   b. Drain
   c. Source
   d. None

3. What polarities of bias voltage would be applied to a JFET's gate and drain for an n-channel? A p-channel?

4. As the gate voltage is increased in a JFET, what happens to the depletion region, drain current, and gate leakage current respectively?

5. With a fixed V_{GS}, as V_{DS} is varied, what area is reached when I_D no longer increases?

6. What is meant by the term BV_{DGS}?

7. Compare the three basic amplifier configurations of the JFET to other device amplifiers.

a. Emitter-follower
b. Grounded-collector
c. Source-follower
d. Common-base
e. Grounded-emitter

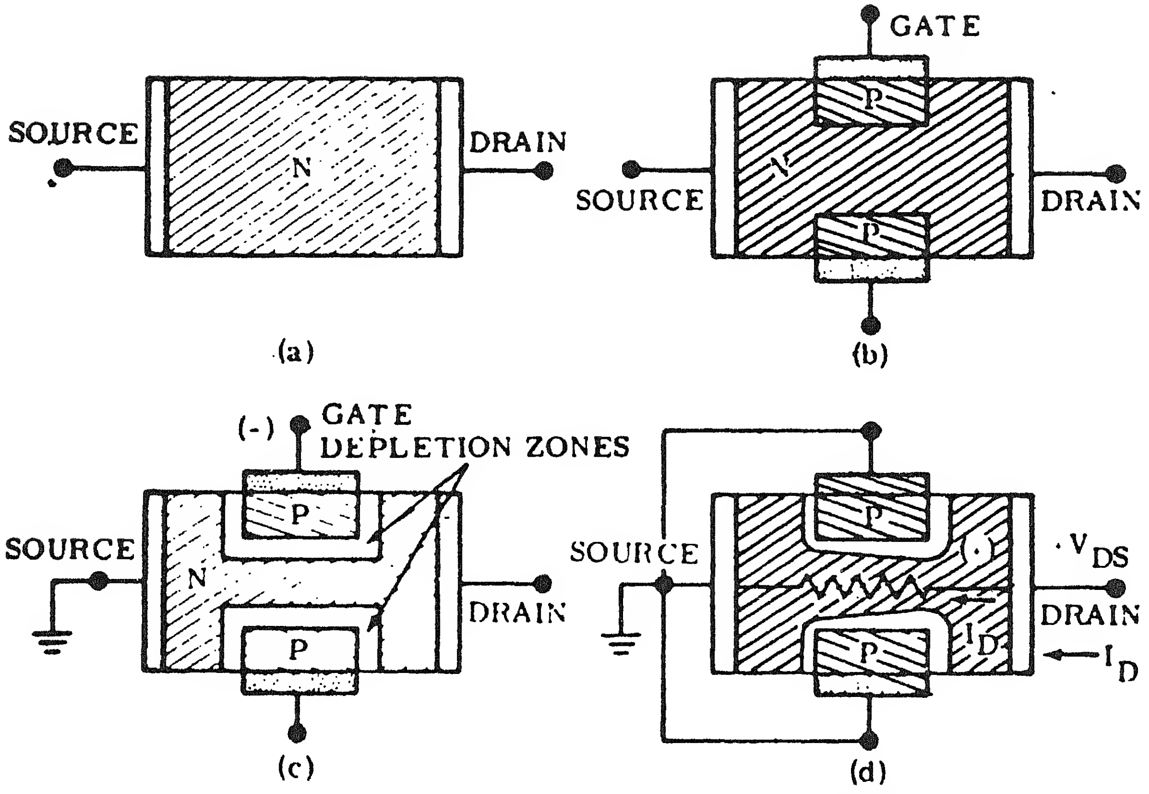
a. Common-source
b. Common-drain
c. Common-gate
d. None

9. What JFET amplifier produces phase inversion of the applied signal?

10. What effect does a positive input signal to a JFET p-channel source follower have on drain current?

11. List the advantages and disadvantages of JFETs.

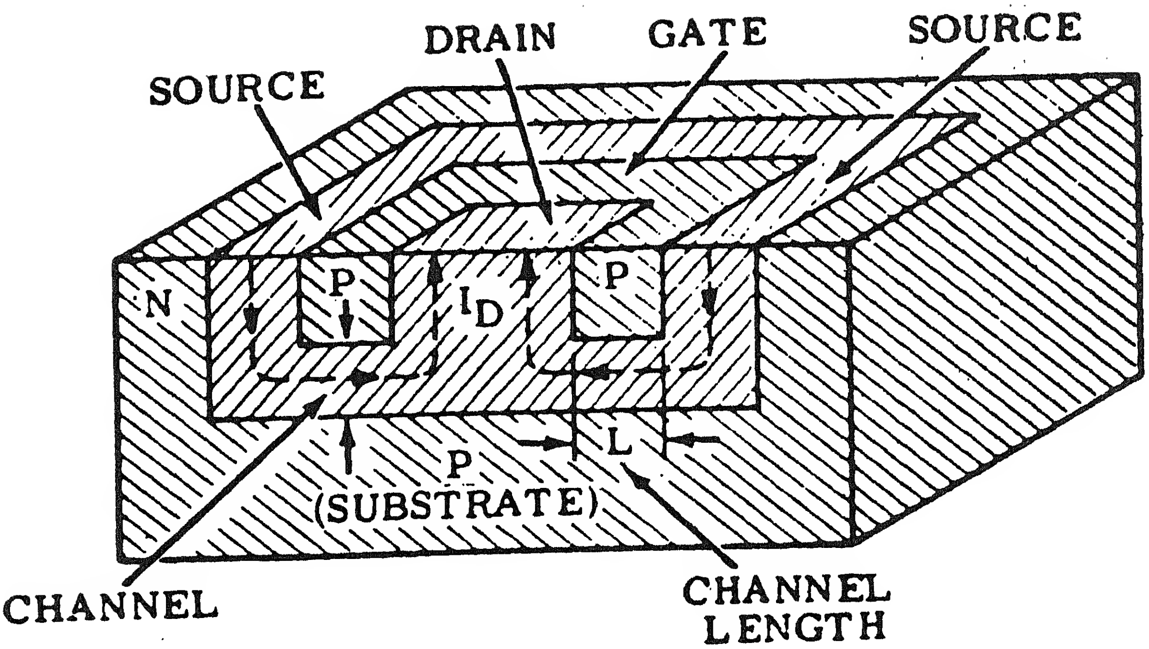
5.1.1D DIAGRAM SHEETS FOR
LESSON TOPIC 5.1



DEVELOPMENT OF JUNCTION FIELD-EFFECT TRANSISTORS

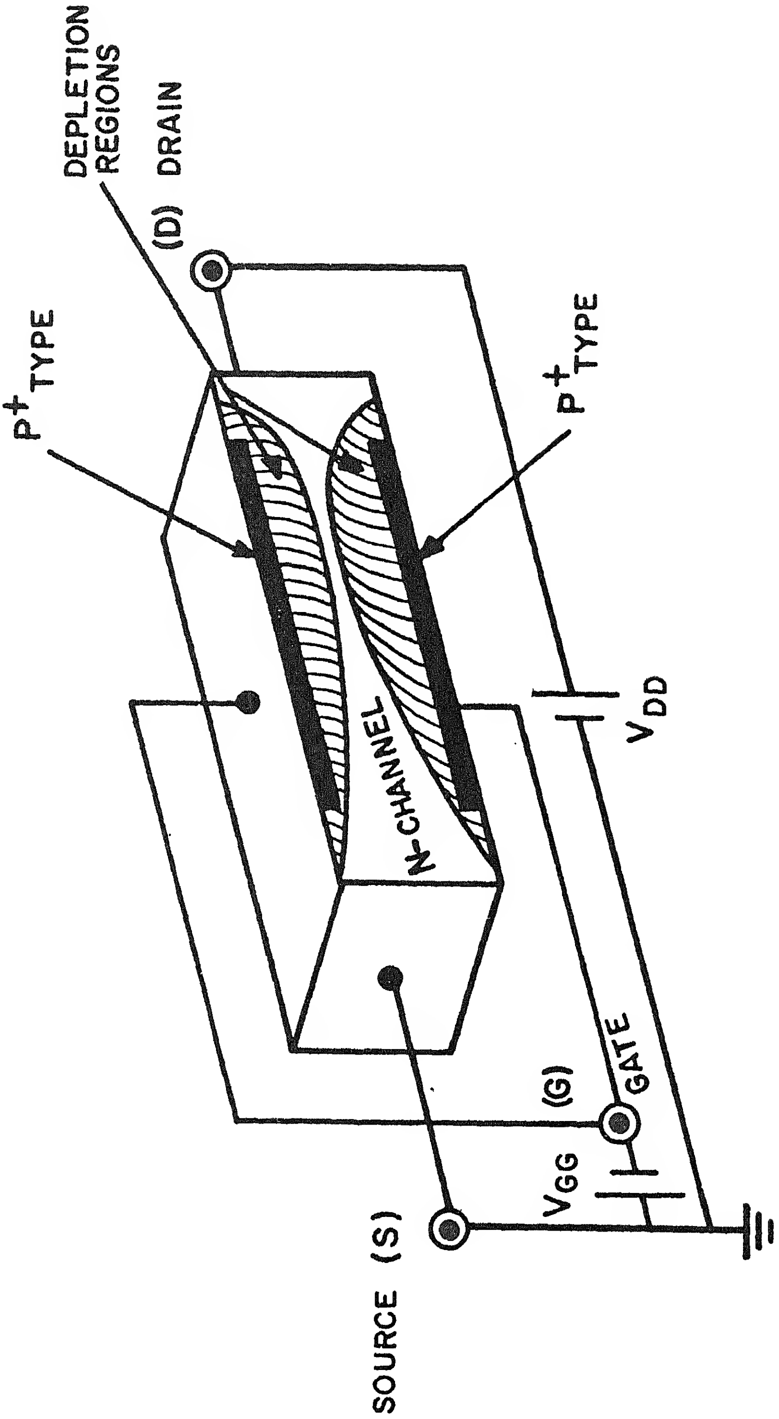
AT-417-68

Figure 1



SINGLE ENDED GEOMETRY JUNCTION FET

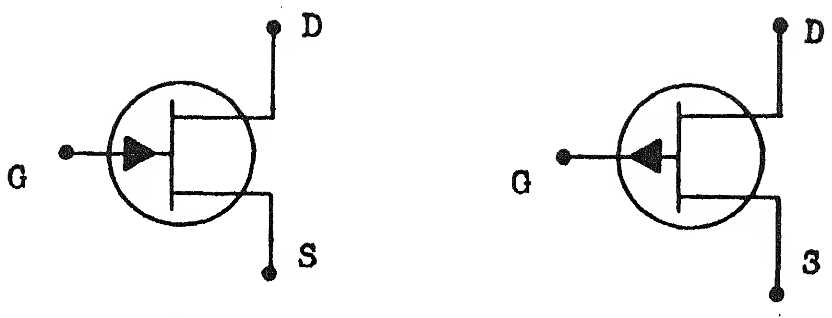
Figure 2



N-CHANNEL FIELD — EFFECT TRANSISTOR

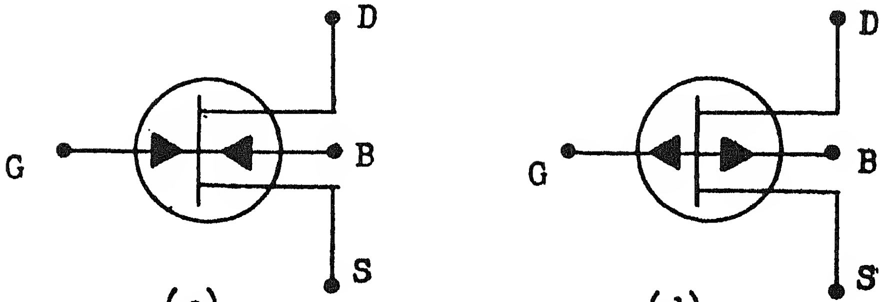
AT-392-72

Figure 3



(a)
N-Channel

(b)
P-Channel



(c)
N-Channel

P-Substrate

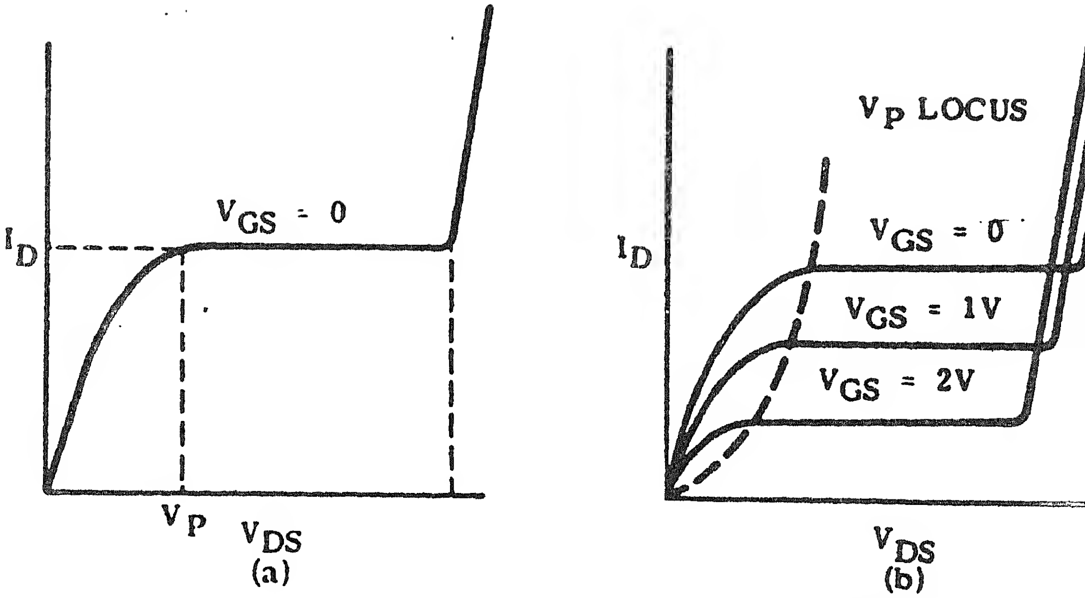
(d)
P-Channel

N-Substrate

JFET SYMBOLOGY

AT-421-68

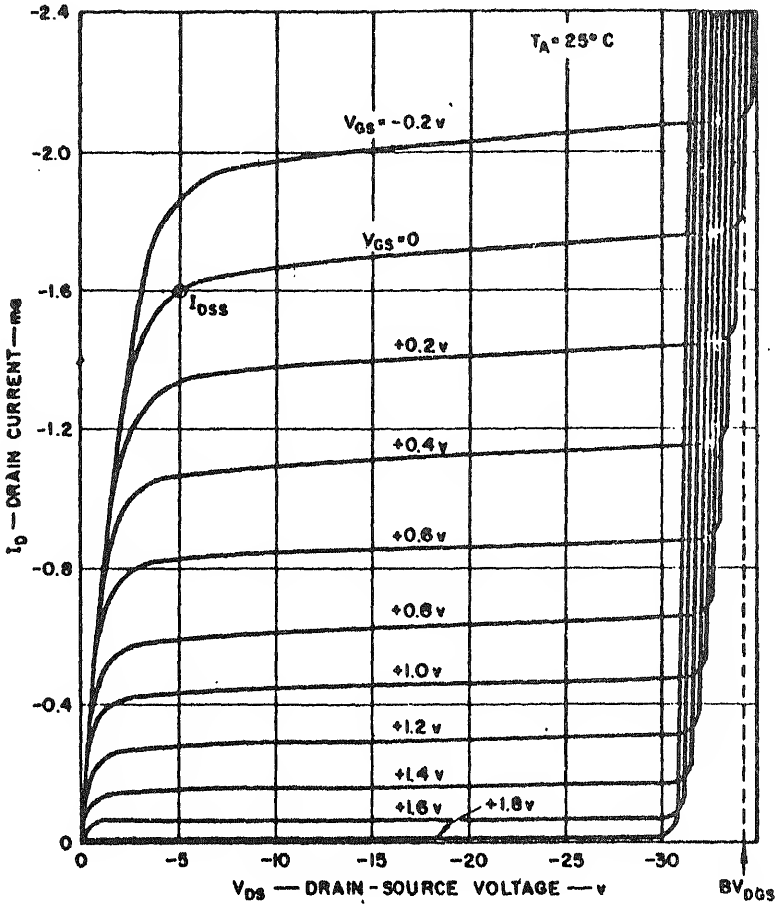
Figure 4



DRAIN CURRENT CHARACTERISTICS

AT-418-

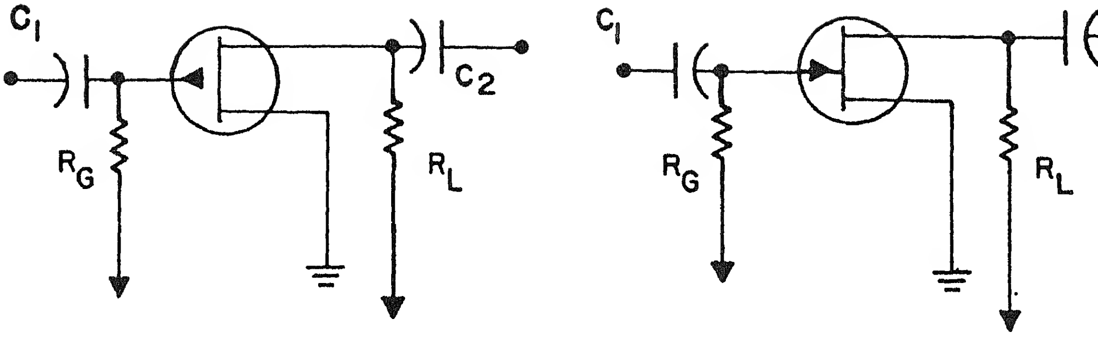
Figure 5



Typical JFET Output Characteristics
2N2608

AT-422-68

Figure 6

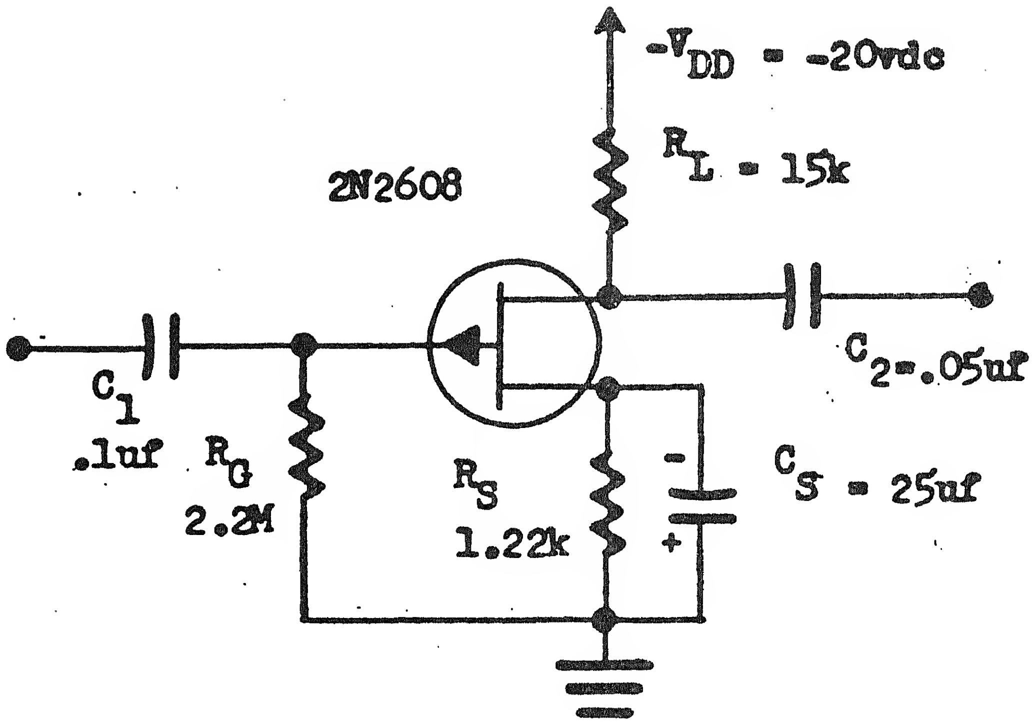


(a) (b)

CS JFET Amplifiers

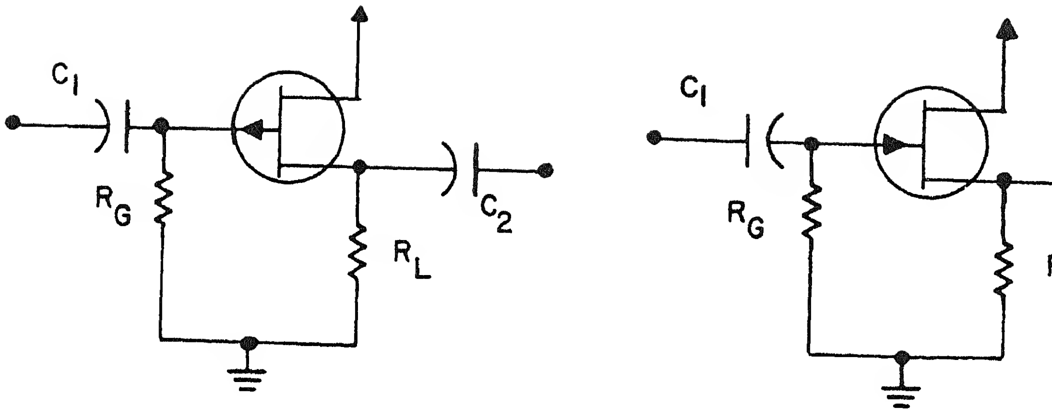
AT-203-

Figure 7



Typical JFET CS Amplifier

Figure 8



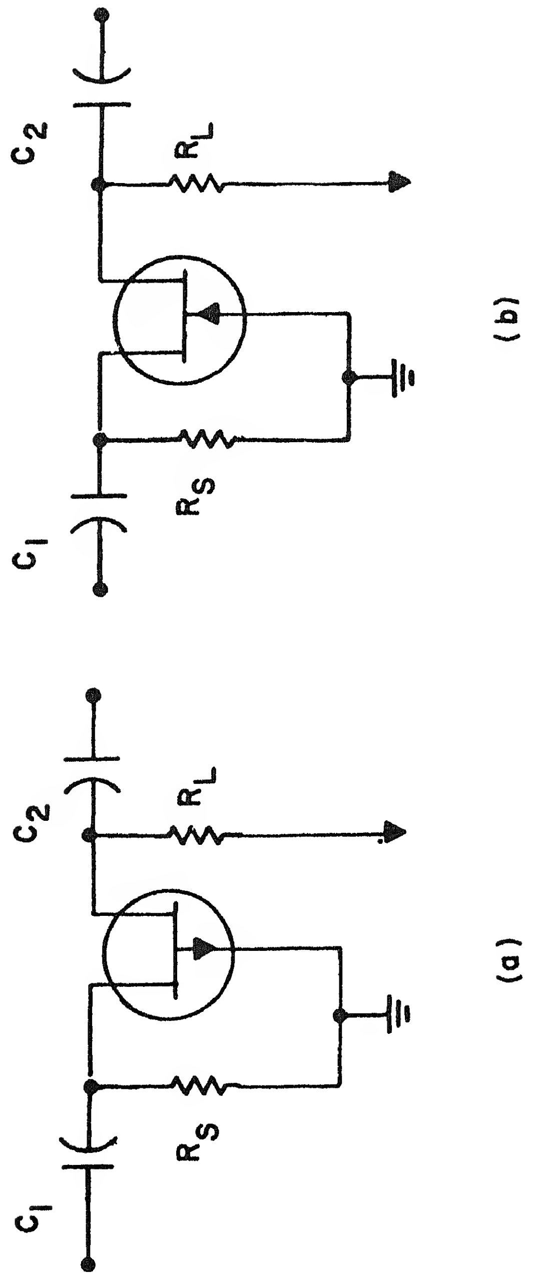
(a)

(b)

JFET CD Amplifiers

AT-204-

Figure 9



JFET CG Amplifiers

AT-202-73

Figure 10

ASSIGNMENT SHEET 5·2·1A
METAL OXIDE SEMICONDUCTOR FIELD EFFECT TRANSISTOR

INTRODUCTION: This assignment will provide questions whic directly relate to the learning objectives listed below. If you can accomplish this assignment, you have met the requirements c the learning objectives. It is recommended that you answer these questions with the same materials as those you will have when taking the progress test. In this way, you will be testing yourself.

LESSON TOPIC LEARNING OBJECTIVES:

5.2.1. Given a list of statements, select the definition o Metal-Oxide Semiconductor Field Effect Transistor (MOSFET).

5.2.2. Given statements concerning the construction of enhancement MOSFETs, select the correct statement(s

5.2.3. Given a block diagram of an enhancement MOSFET, label the substrate, drain, gate, source and type channel.

5.2.4. Given statements concerning the operation of enhanc ment MOSFETs, select the correct statement(s).

5.2.5. Given statements comparing the three basic circuit configurations of enhancement MOSFETs, select the correct statement(s).

5.2.6. Given schematic diagrams for enhancement MOSFET amp lifiers, label the drain, gate, source and substrat and list the following:

A. Circuit configuration

B. Type channel

C. Type biasing

5.2.7. Given an output characteristics graph for an enhanc ment MOSFET, label drain current (I_D), drain to source voltage (V_{DS}), gate to source voltage (V_{GS}) and threshold voltage (V_T).

5.2.8. Given statements concerning the construction of a depletion MOSFET, select the correct statement(s).

9. Given statements concerning the operation of a depletion MOSFET, select the correct statement(s).

10. Given a schematic diagram of a depletion MOSFET, label the drain, source, gate, substrate, and list the following:

    A. Circuit configuration

    B. Type channel

    C. Type biasing

11. Given a family of output characteristics for a depletion MOSFET, label drain current I_D, drain to source voltage V_{DS}, and pinchoff voltage (V_P).

12. Given statements comparing depletion to enhancement MOSFETs, select the correct statement(s).

13. Given statements concerning the application of FETs, select the correct statement(s).

14. Given statements concerning dual-gate MOSFETs, select the correct statement(s).

DY ASSIGNMENT:

Boylestad and Nashelsky, Electronic Devices and Circuit Theory, 3rd Ed., Prentice-Hall, 1982, Ch. 5, pp 199-205, Ch. 6, pp 217-220.

PLETE: STUDENT ACTIVITY GUIDE 5.2.1S

DY QUESTIONS: NONE

STUDENT ACTIVITY GUIDE 5.2.1S

METAL-OXIDE SEMICONDUCTOR FIELD EFFECT TRANSISTORS

1. The MOSFET differs from the bipolar transistor and the JFET in that it (select the correct statements.)

____a. has unipolar majority carriers.
____b. is a voltage controlled device.
____c. utilizes a forward-biased pn junction for contro of unipolar carriers.
____d. has a high input impedance with forward or rever bias applied.

2. Match the electrodes of other devices to the MOSFET whic are similar.

____a. Anode
____b. Base
____c. Emitter
____d. Collector

a. Gate No. 1
b. Drain
c. Source
d. Gate No. 2
e. None

3. What polarities of bias voltage would be applied to an enhancement MOSFET's gate and drain for an n-channel? A p-channel?

4. As the gate voltage is increased positive in a MOSFET depletion type n-channel, what happens to the depletio region, drain current, and gate leakage current, respectively?

5. With a fixed V_{GS}, as V_{DS} is varied, what area is reach when I_D no longer increases?

MOSFET to other device amplifiers.

_____a. Emitter-follower
_____b. Grounded-collector
_____c. Source-follower
_____d. Common-base
_____e. Grounded-emitter

a. Common-source
b. Common-drain
c. Common-gate
d. None

7. What MOSFET amplifier produces polarity inversion of the applied signal?

8. What effect does a positive input signal to a p-channel depletion type MOSFET source follower have on drain current?

9. What is the major difference between a JFET and MOSFET in respect to biasing?

10. Why is thermal runaway almost impossible in MOSFETs?

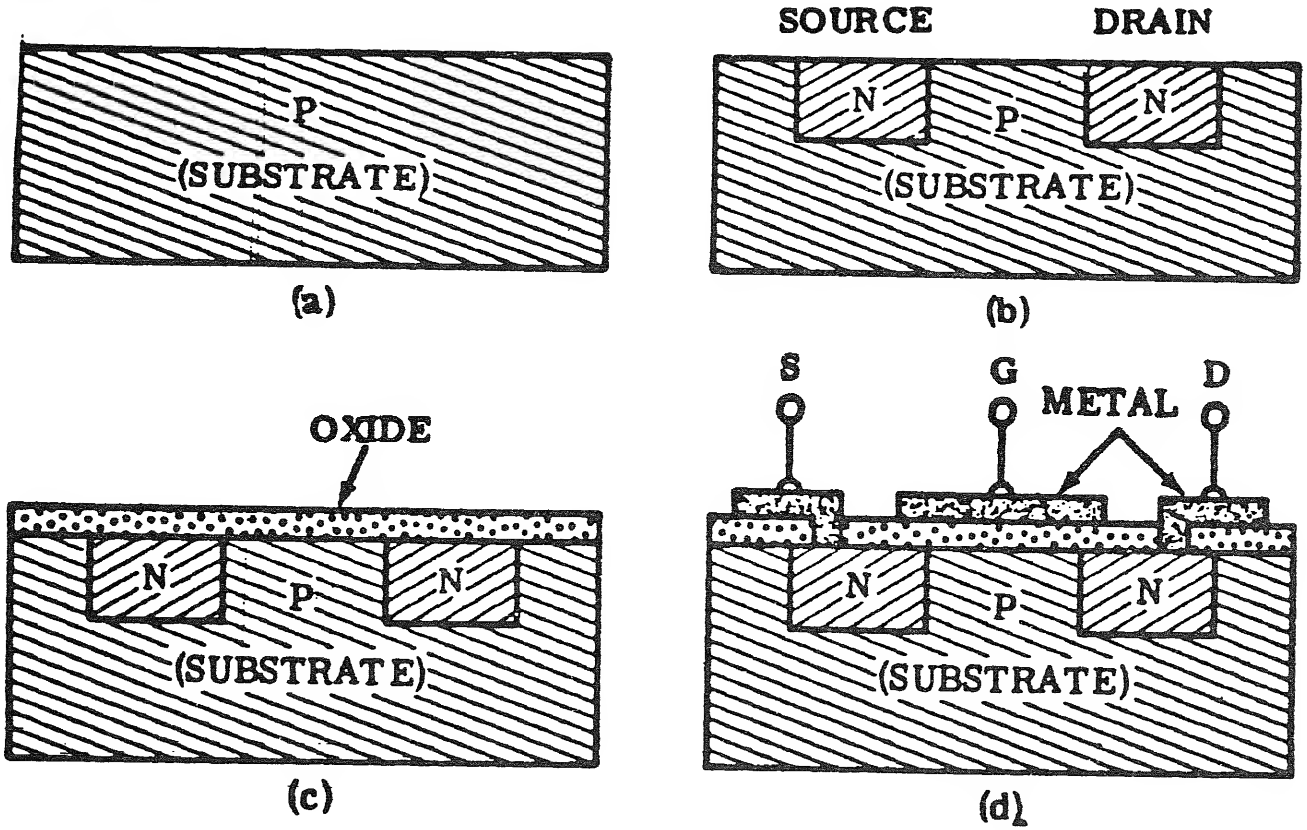
11. Select the following statements which are correct in regard to MOSFETs.

_____a. $I_D = f(V_{GS}, V_{DS})$
_____b. Operation in both enhancement and depletion modes is possible.
_____c. No voltage gradient in the channel is produced.
_____d. Static charges enhance gate current.
_____e. Enhancement mode types must be biased "on" for Class "A" operation.
_____f. Depletion mode types must be biased toward "off" for Class "A" operation.
_____g. V_P occurs after BV_{GDS}.
_____h. Punch through occurs before V_P.
_____i. The gate forms a PN junction with the channel area.
_____j. The substrate is always tied to the source.

12. Which lead carries the arrowhead symbol, of the MOSFET symbol, as used in this course?

13. What effects does a negative input signal to a p-channel enhancement-type MOSFET have on I_D? Channel resistance? V_D? (In a common source configuration).

DIAGRAM SHEETS FOR
LESSON TOPIC 5.2



Enhancement MOSFET Construction

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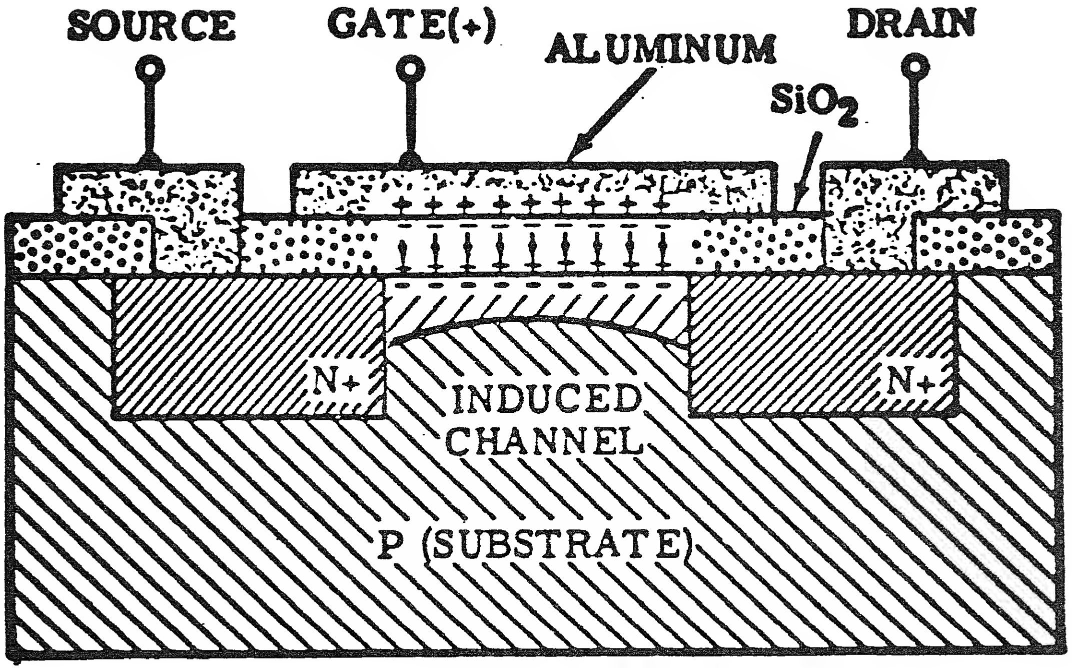
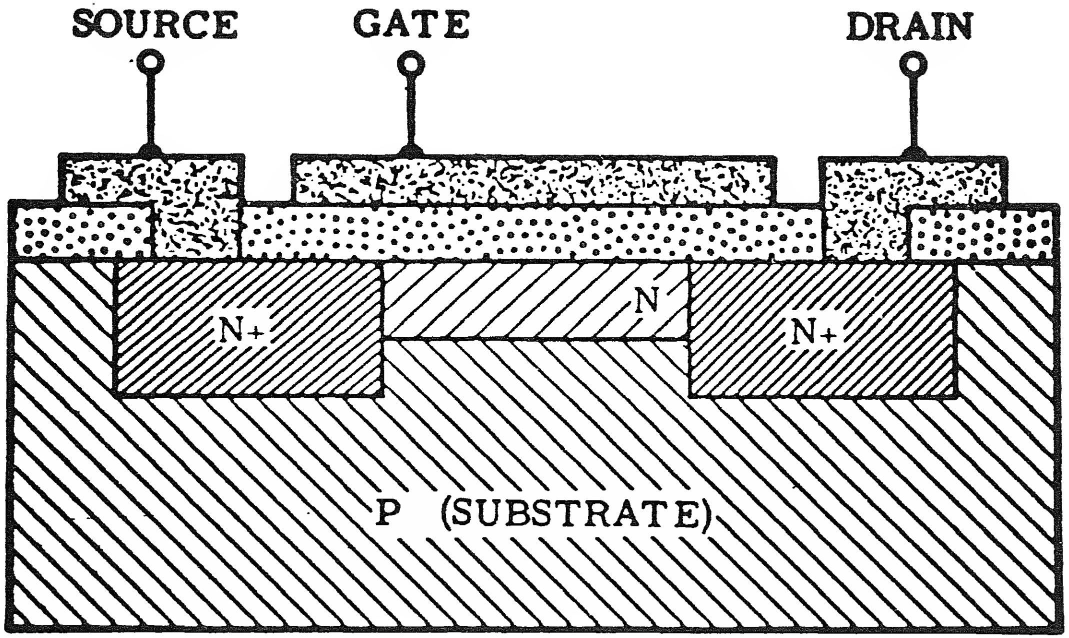


CHANNEL ENHANCEMENT

AT-428-68

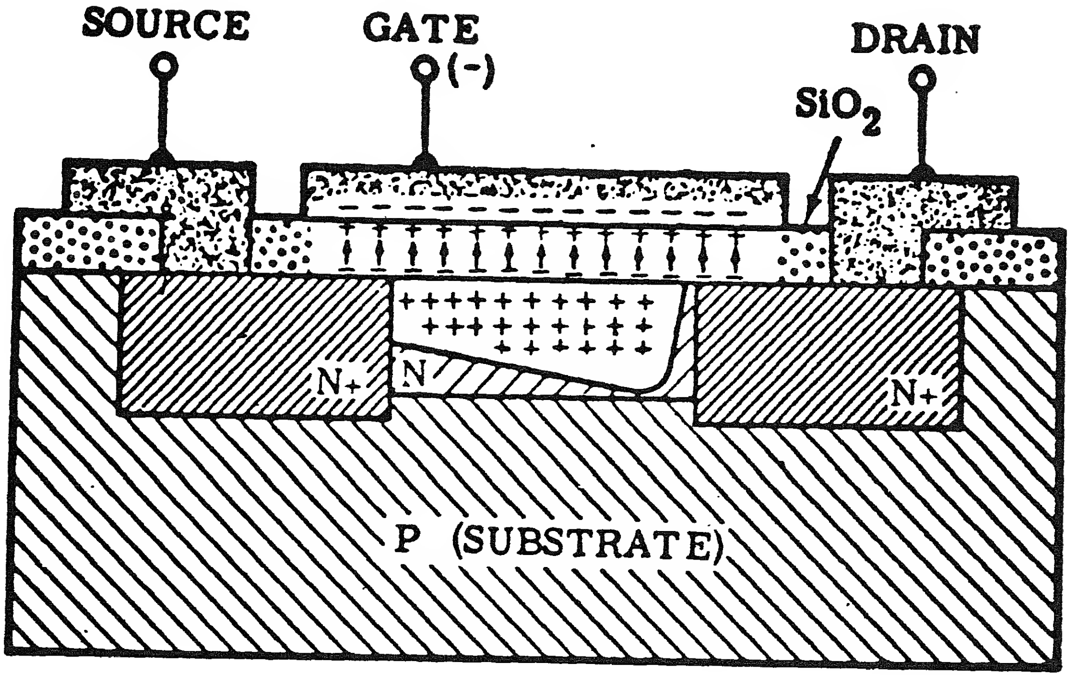
Figure 2



Depletion MOSFET

AT-429-68

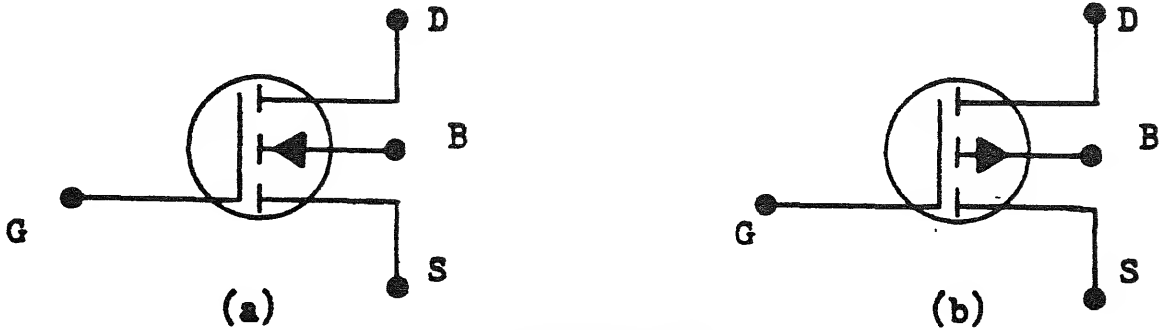
Figure 3



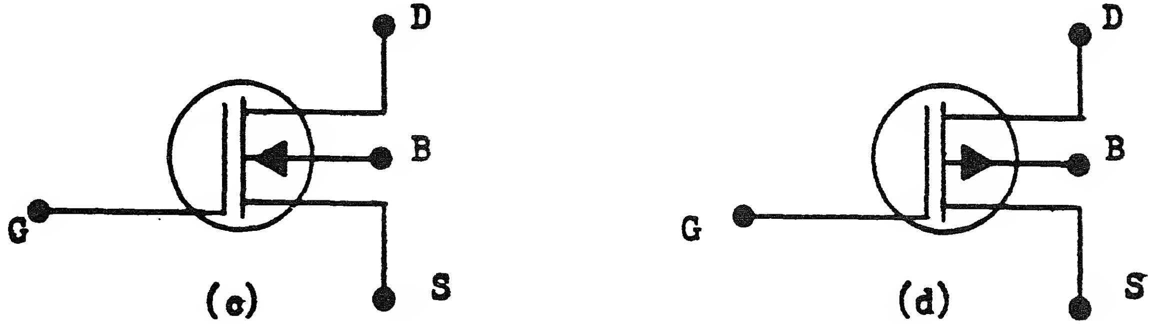
CHANNEL DEPLETION

AT-430-68

Figure 4



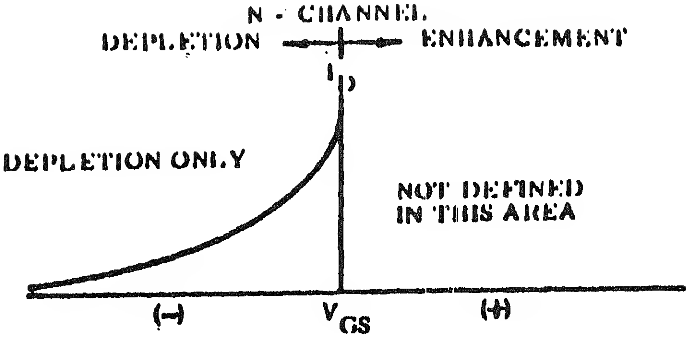
ENHANCEMENT



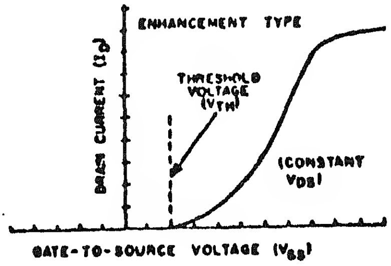
DEPLETION

MOSFET Symbols

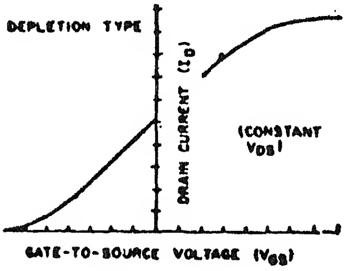
AT-431-68



(a) Depletion Type MOSFET



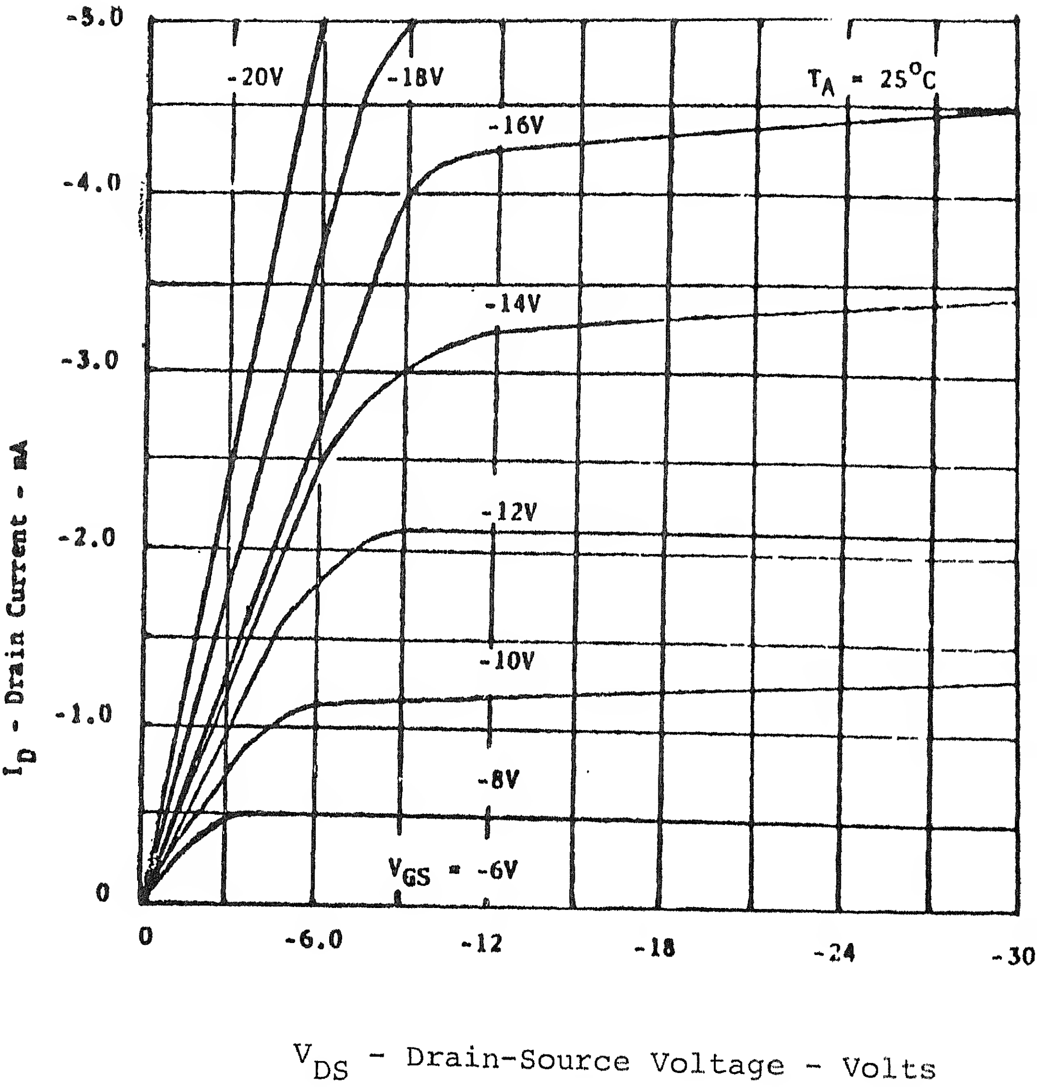
(b) Enhancement Type MOSFET



(c) Depletion or Enhancement-Depletion MOSFET

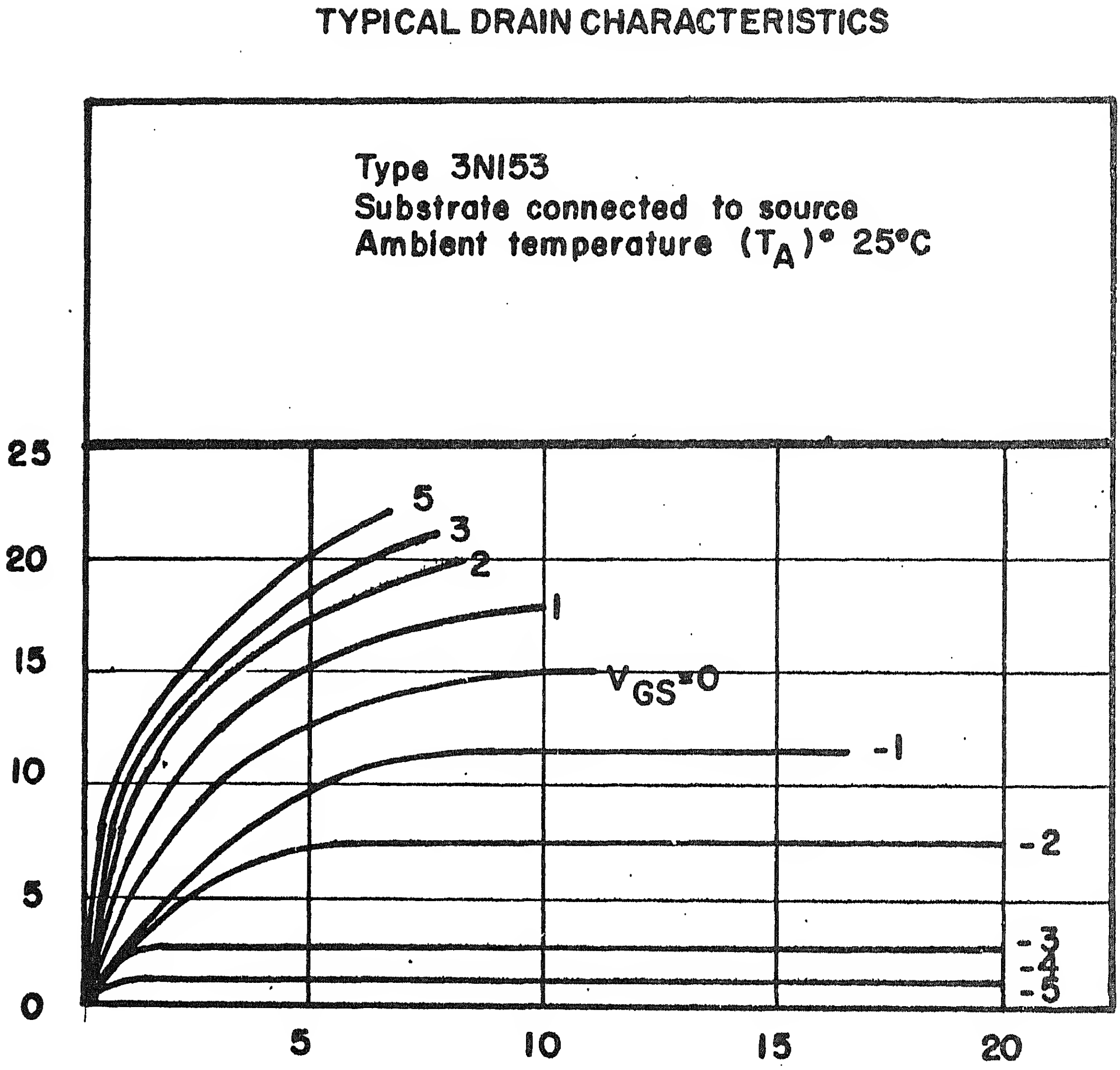
OTE: The area to the left of I_D indicates reverse bias gate voltage. Conversely, the area to the left of I_D indicates forward bias voltage.

Figure 6 - MOSFET Transfer Characteristics



MOSFET Output Characteristics, Enhancement Mo

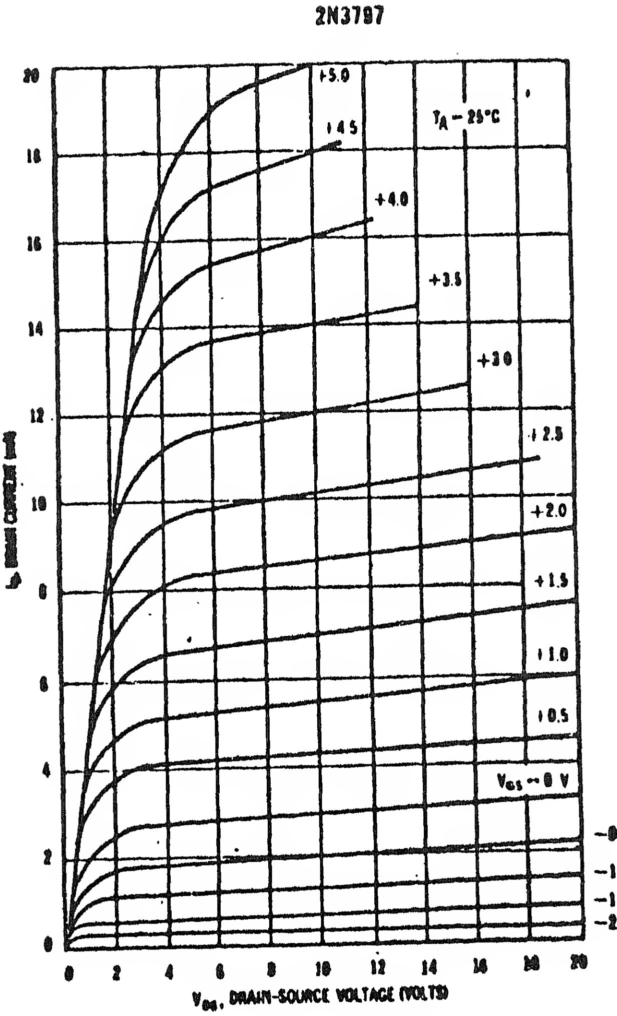
Figure 7



DRAIN-TO-SOURCE VOLTS (V_{DS})

MOSFET Output Characteristics, Depletion Mode

Figure 8



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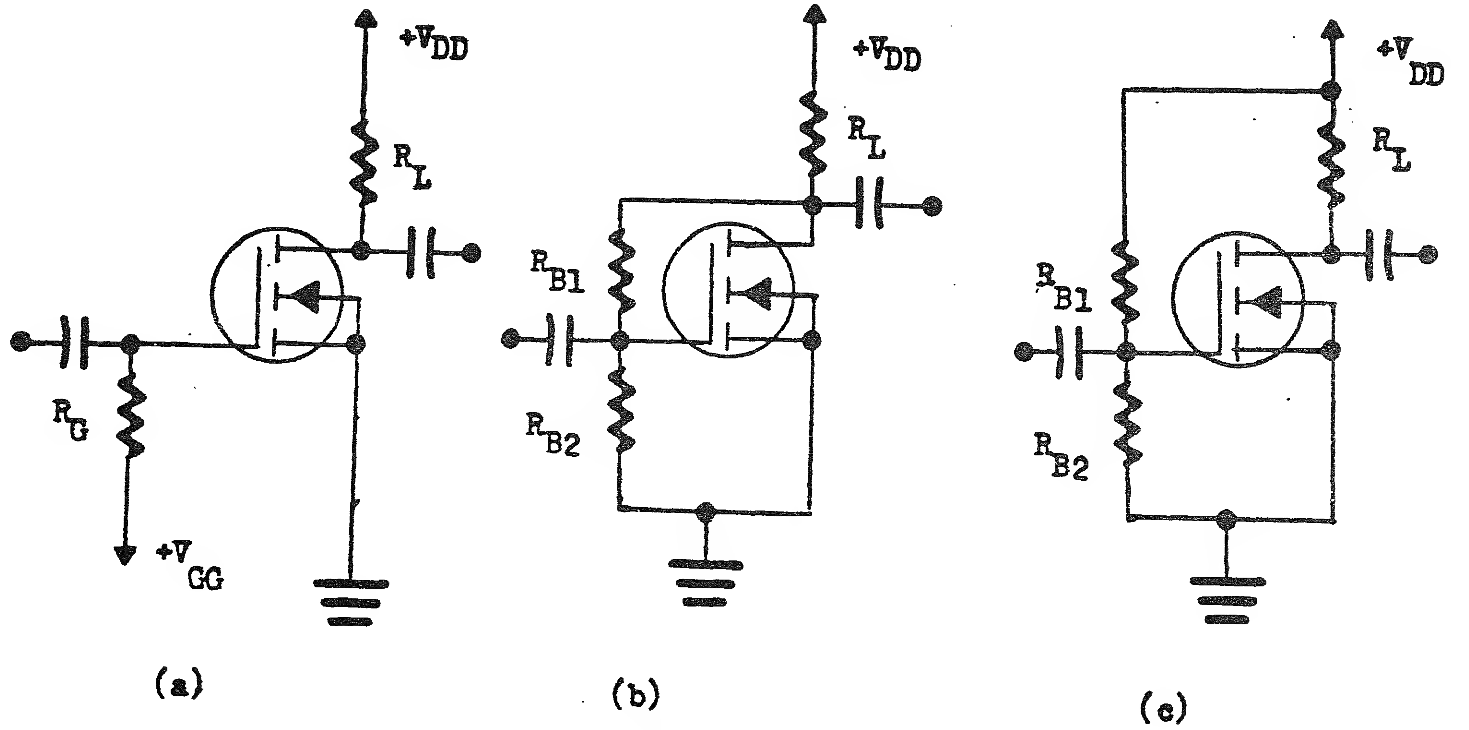
MOSFET Output Characteristics, Depletion-Enhancement Mode

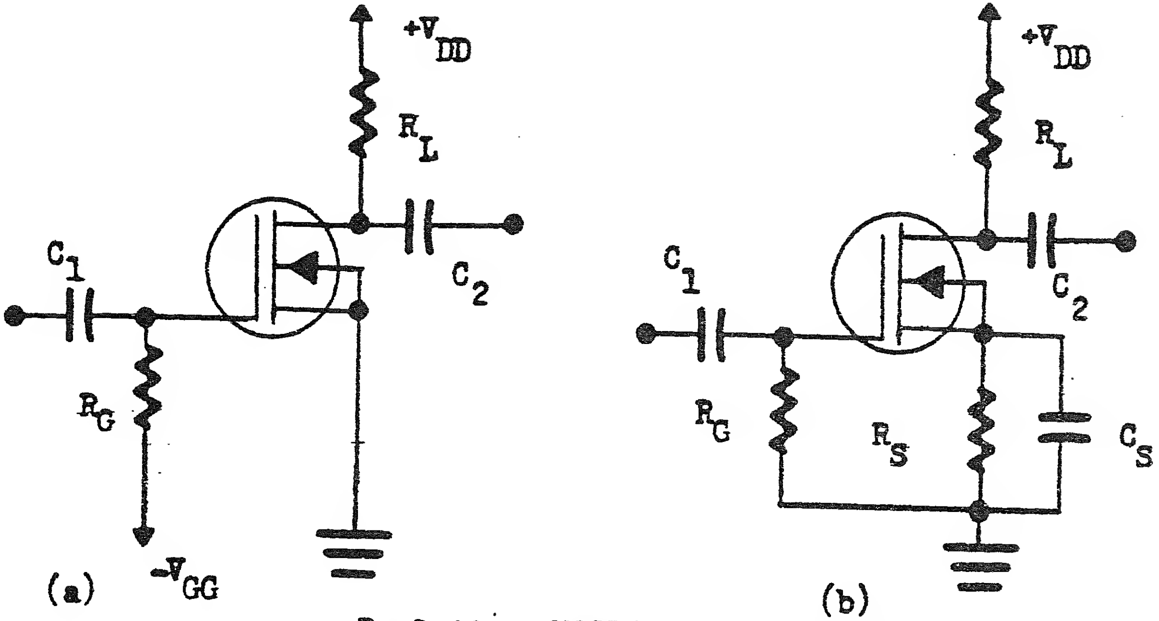
Figure 9



Enhancement MOSFET CS Amplifiers

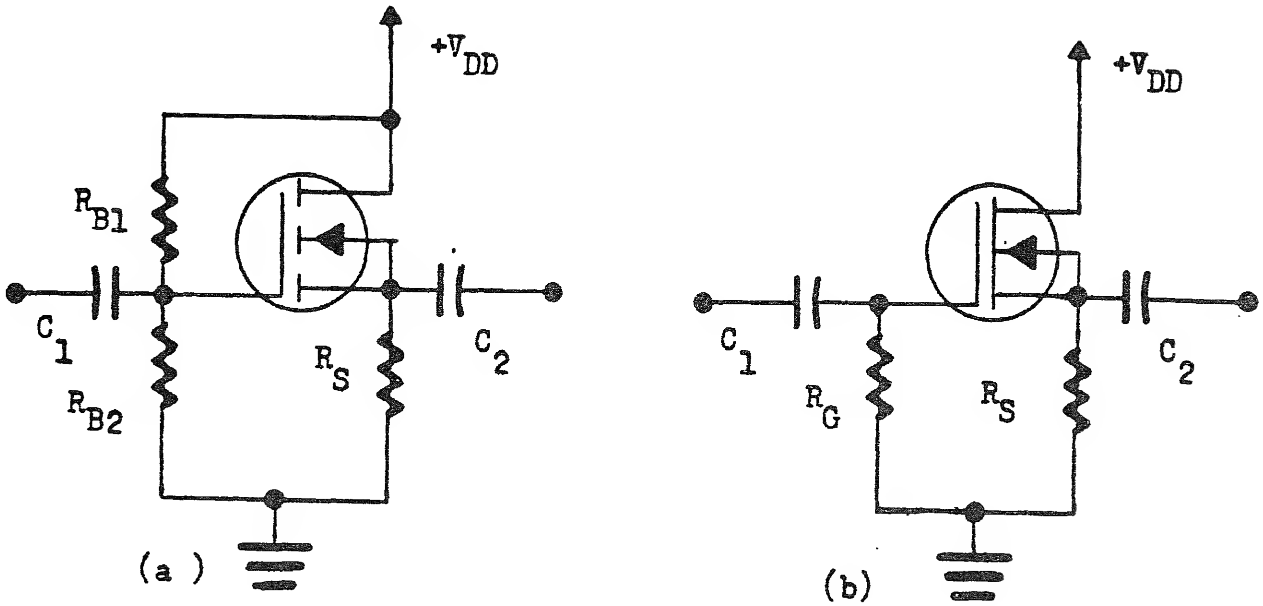
AT-436-68

Figure 10



Depletion MOSFET CS Amplifiers

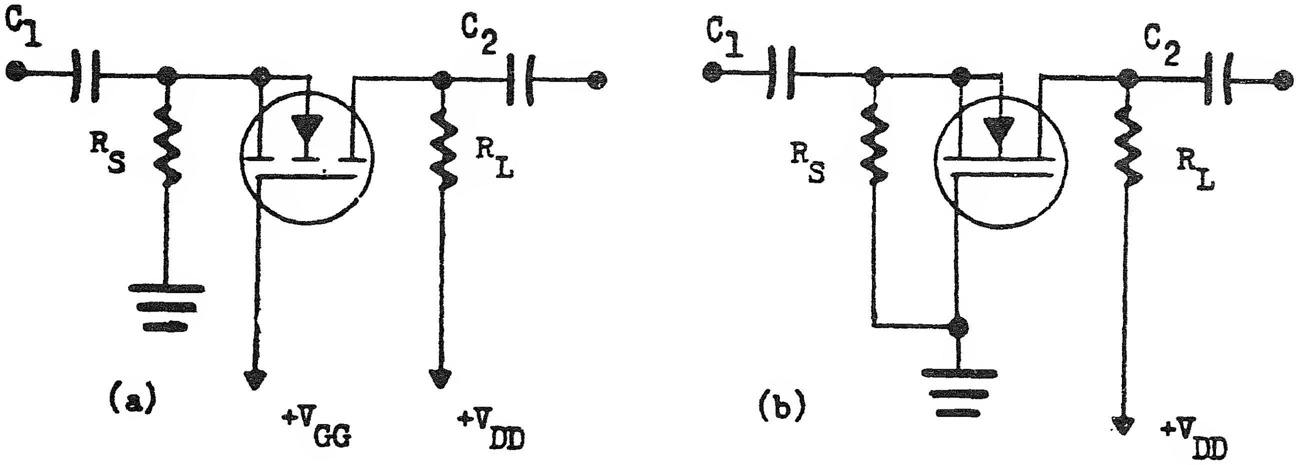
AT-437-68



MOSFET Source-Followers

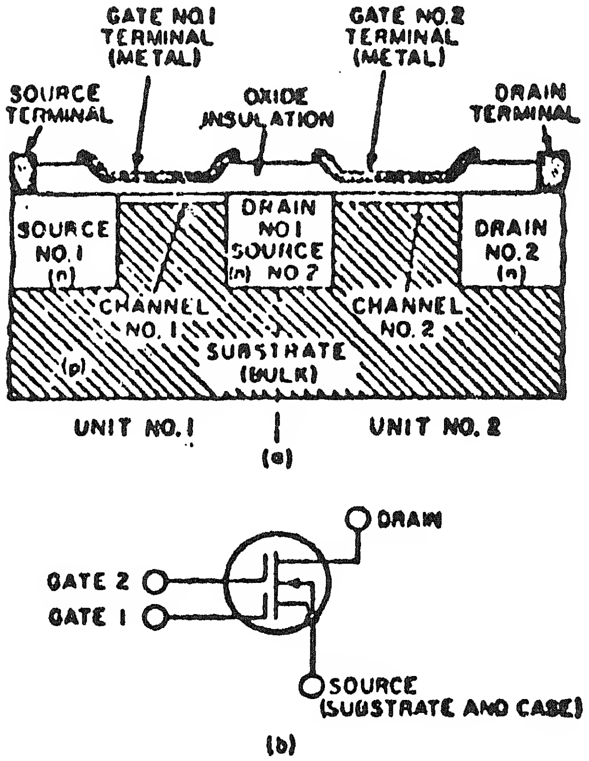
AT-438-68

Figure 12



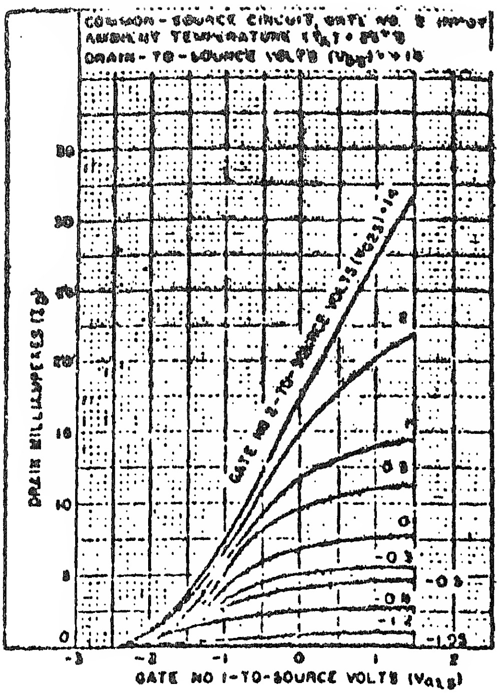
MOSFET CG Amplifiers

MOS Field-Effect Transistors

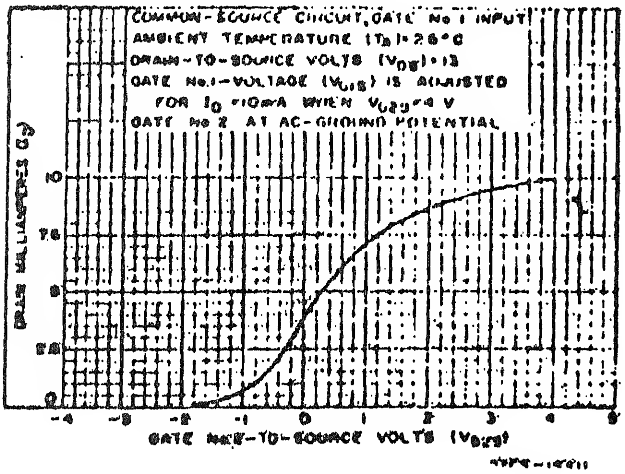


Dual-gate N-channel depletion-type
MOS field-effect transistor;
(a) Side-view cross section;
(b) Schematic symbol

Figure 14

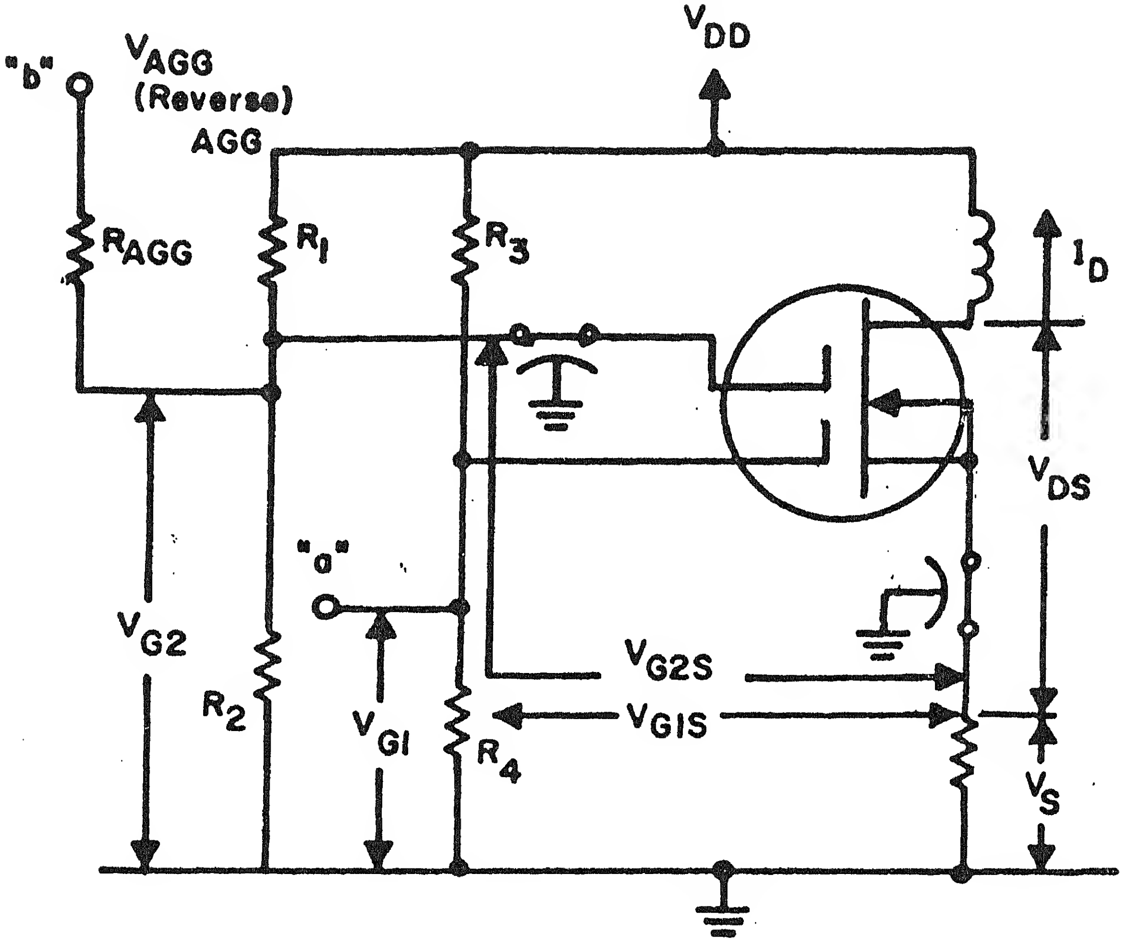


(A) Drain Current vs Gate-No. 1-to-Source Volts



(B) Drain Current vs Gate No. 2-to-Source Voltage

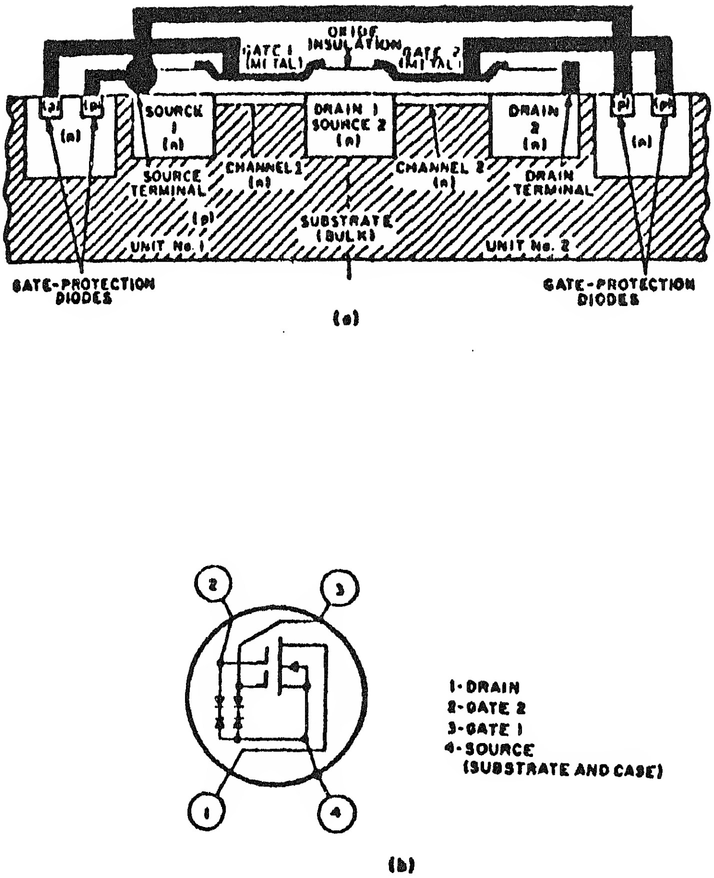
Typical Drain Current Curves for a Dual Gate MOSFET



TYPICAL BIASING CIRCUIT FOR DUALGATE MOS FIELD-EFFECT TRANSISTORS

Typical biasing circuit for dual-gate MOS field-effect transistors.

Figure 16



AT-226-73

Dual-gate-protected n-channel depletion-type MOS field-effect transistor;
(a) Side-view cross section;
(b) Schematic symbol.

Figure 17

ASSIGNMENT SHEET 5.3.1A

Special Semiconductor Devices

INTRODUCTION:

This assignment is designed to provide enhancement and reinfor ment to the concepts discussed in the classroom and verified i the laboratory. During this assignment questioning should be applied to insure complete under-standing.

ENABLING OBJECTIVES:

5.3.1 List the two properties of light to which photo devices ar sensitive.

5.3.2 List the three properties of semiconductors that determine their characteristics as photo-sensitive devices.

5.3.3 Given statements concerning the theory of operation for th following photosensitive devices, select the correct statement(s):

A. Photodiode

B. Photovoltaic cell

C. Phototransistor.

5.3.4 Given statements concerning the application of photo-sensitive devices, select the correct statement(s).

5.3.5 Given a list of statements, select the definition of a Light Emitting Diode (LED)

5.3.6 Given statements concerning the theory of operation of an LED, select the correct statement(s).

5.3.7 Given statements concerning applications of LEDs, select the correct statement(s).

5.3.8 Given schematic symbols for special semiconductor devices, correctly label each with the device it represents.

5.3.9 Given a list of statements, select the one describing a Diac.

5.3.10 Given statements concerning the theory of operation of a Diac, select the correct statement(s).

5.3.11 Draw the voltage-current characteristics graph for a Diac.

5.3.12 Given a list of statements, select the one describing a Shockley diode.

5.3.13 Given statements concerning the theory of operatio Shockley diode, select the correct statement(s).

5.3.14 Given the voltage-current characteristics for a Sh diode, label the following:

A. Forward voltage (V_F)

B. Forward current (I_F)

C. Forward breakover voltage ($V_{(BR)F}$)

D. Holding current (I_H)

E. Reverse voltage (V_R)

F. Reverse current (I_R)

G. Reverse breakover voltage ($V_{(BR)R}$)

5.3.15 Given statements concerning the methods used to tu Shockley diodes, select the correct statement(s).

5.3.16 Given statements concerning the general characteri a Silicon Controlled Rectifier (SCR), select the c statement(s).

5.3.17 Given statements concerning the construction of SC select the correct statement(s).

5.3.18 Given statements concerning the the theory of oper an SCR, select the correct statement(s).

5.3.19 Given statements comparing the voltage-current cha tics of an SCR and a Shockley diode, select the co statement(s).

5.3.20 Given statements concerning the applications of SC select the correct statement(s).

5.3.21 Given a list of statements describing a Triac, sel correct statement(s).

5.3.22 Given statements concerning the construction of Tr select the correct statement(s).

5.3.23 Given statements concerning the theory of operatio Triac, select the correct statement(s).

5.3.24 Draw a voltage-current characteristics graph for a devices:

A. Diac

B. Shockley diode

C. SCR

D. Triac

5.3.26 Given a list of statements describing a Unijunction Transistor (UJT), select the correct statement(s).

5.3.27 Given statements concerning the construction of UJTs, select the correct statement(s).

5.3.28 Given statements concerning the theory of operation of UJTs, select the correct statement(s).

5.3.29 Given the emitter characteristics graph for a UJT, label the following:

A. Emitter voltage (V_E)

B. Emitter current (I_E)

C. Peak voltage and current (V_P & I_P)

D. Valley voltage and current (V_V & I_V)

E. Cutoff, negative resistance and saturation regions.

5.3.30 Given statements concerning the applications of UJTs, select the correct statement(s).

5.3.31 Given a schematic diagram of a UJT relaxation oscillator, its parameters and a formula sheet, compute the frequency of oscillation (fosc).

5.3.32 List the element(s) of a UJT that could provide the following:

A. A trigger for an SCR

B. A trigger for a Triac

C. A sweep signal

5.3.33 List four advantages of a planer UJT over the bar type.

5.3.34 Given specified test equipment and a special semicond
circuit trainer, IAW the job sheet, evaluate the oper
of the following devices:

A. Unijunction Transistor (UJT)

B. Silicon Controlled Rectifier (SCR)

C. Tunnel diode

D. Varicap

STUDY ASSIGNMENT:

Read: 1. Boylestad and Nashelsky, Electronic Devices and Theory, 3rd Ed., Prentice-Hall, 1982, Ch.2, pp Ch.11, pp 419-458.

Complete: Student Activity Guide 5.3.1S

STUDY QUESTIONS: None

What are three things that control the activation of a photosensitive device?

a.
b.
c.

The photo diode operates on _______________ carriers.

The small current that flows in a photoelectric cell in the static state is known as __________ ____________.

The photovoltaic cell is basically a _________ generator.

Photosensitive devices are sensitive only to light intensity. (True/False)

How is each of the following devices biased?

a. Photodiode
b. Photovoltaic cell
c. LED
d. Phototransistor

The impedance of a PNPN diode prior to breakdown is

__a. low because of charge multiplication.
__b. high because of an internal reverse-biased junction.
__c. low because of two forward-biased junctions.
__d. high because of a small value of minority carrier flow.

Concerning the basic SCR, select the correct statements.

__a. The gate loses control of anode current after breakdown.
__b. The gate initiates breakdown.
__c. The gate is voltage control of the device.
__d. A specific amount of gate current is required for turn-on of the SCR.

Concerning the SCR or after breakover, select the correct statements.

__a. Current flow is equal to I_H and is constant.
__b. Load current is limited by load resistance.
__c. Load current is equal to gate current.
__d. Load voltage is equal to the voltage across the SCR.
__e. The SCR cannot be commutated.

. What is the main purpose behind commutation?

11. What type of device is a unijunction transistor?

____a. Dual PN junction.
____b. High-voltage-gain PN transistor.
____c. Unipolar current amplifier.
____d. Unilateral voltage-ratio-activated device.
____e. Negative resistance switch.
____f. Double-base diode.

12. The UJT can be used as a/an

____a. audio amplifier.
____b. switch for load current.
____c. relaxation oscillator.
____d. timer.
____e. pulse generator.
____f. voltage regulator.

13. Write the definition of an LED.

14. How many degrees of maximum load current control do each of the following have?

a. SCR ____________
b. TRIAC __________

15. What is the purpose of the diac?

16. Title the following schematic symbols in figure 1.

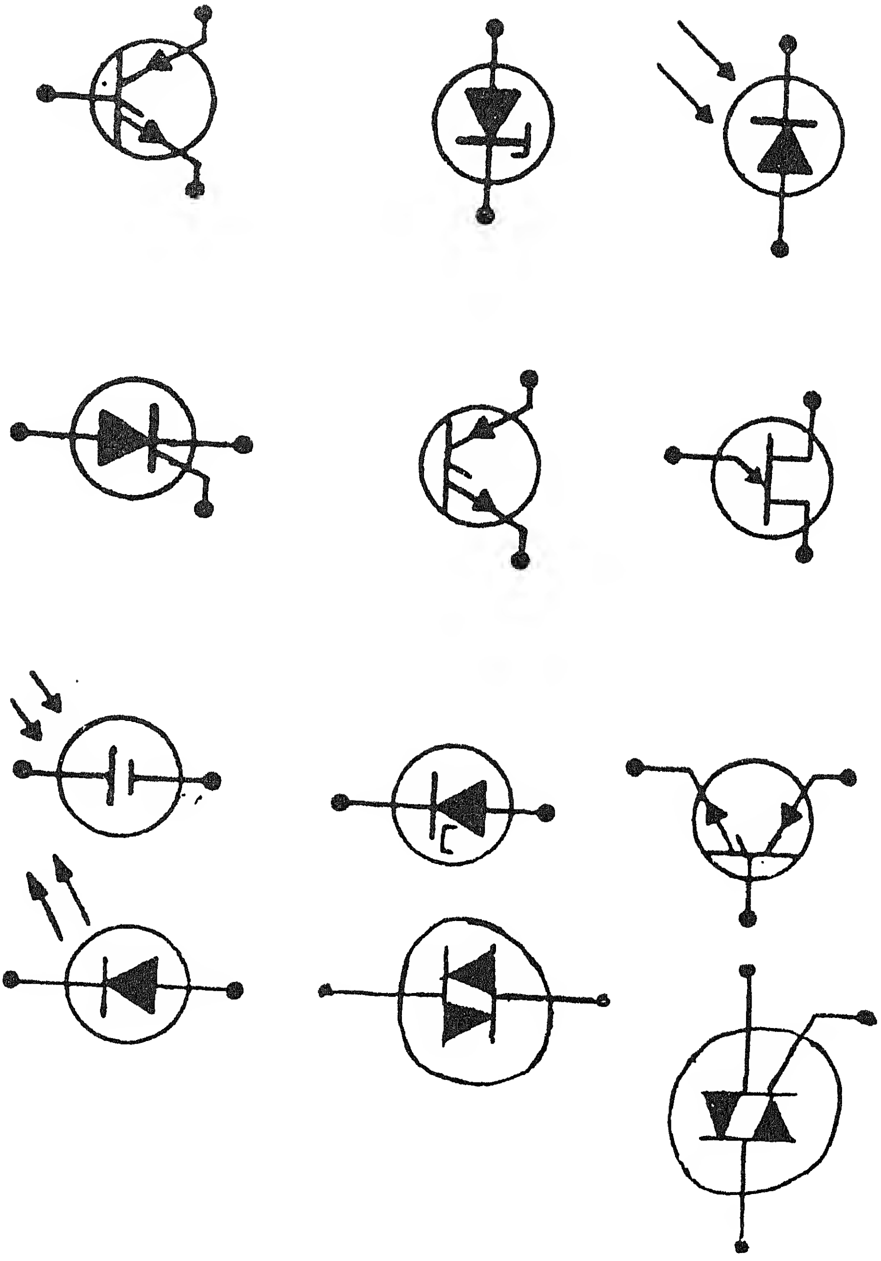


Figure 1

JOB SHEET 5.3.1J

TITLE: Special Semiconductor Devices

JOB SHEET NO. 5.3.1J Time: 8 Periods

INTRODUCTION:

In previous lessons and experiments you have learned the t
and applications of the common NPN and PNP transistors. In th
lesson you have studied the theory of several special semicond
devices. The purpose of this Job Sheet is to emphasize and ve
the theories discussed in the classroom. You will perform exp
ments with the UJT, SCR, tunnel diode and varicap, which are d
to enhance your understanding of these devices and add to your
technical confidence.

LESSON TOPIC LEARNING OBJECTIVE:

1. Given specified test equipment and a special semiconductor trainer, IAW the Job Sheet, evaluate the operation of the following devices.

   a. Unijunction Transistor (UJT)
   b. Silicon Controlled Rectifier (SCR)

REFERENCE

1. Advanced Semiconductor Circuits, RCA Service Company Div., 1971, pp. 83-91, 181-189, 205-210 and 133-143

EQUIPMENT AND MATERIALS:

1. RCA Digital Computer Trainer (6F16)
2. Multimeter Simpson 260
3. VTVM, RCA Model WV-77E/Fluke Model 8000A
4. Oscilloscope, Tektronix 453

JOB STEPS:

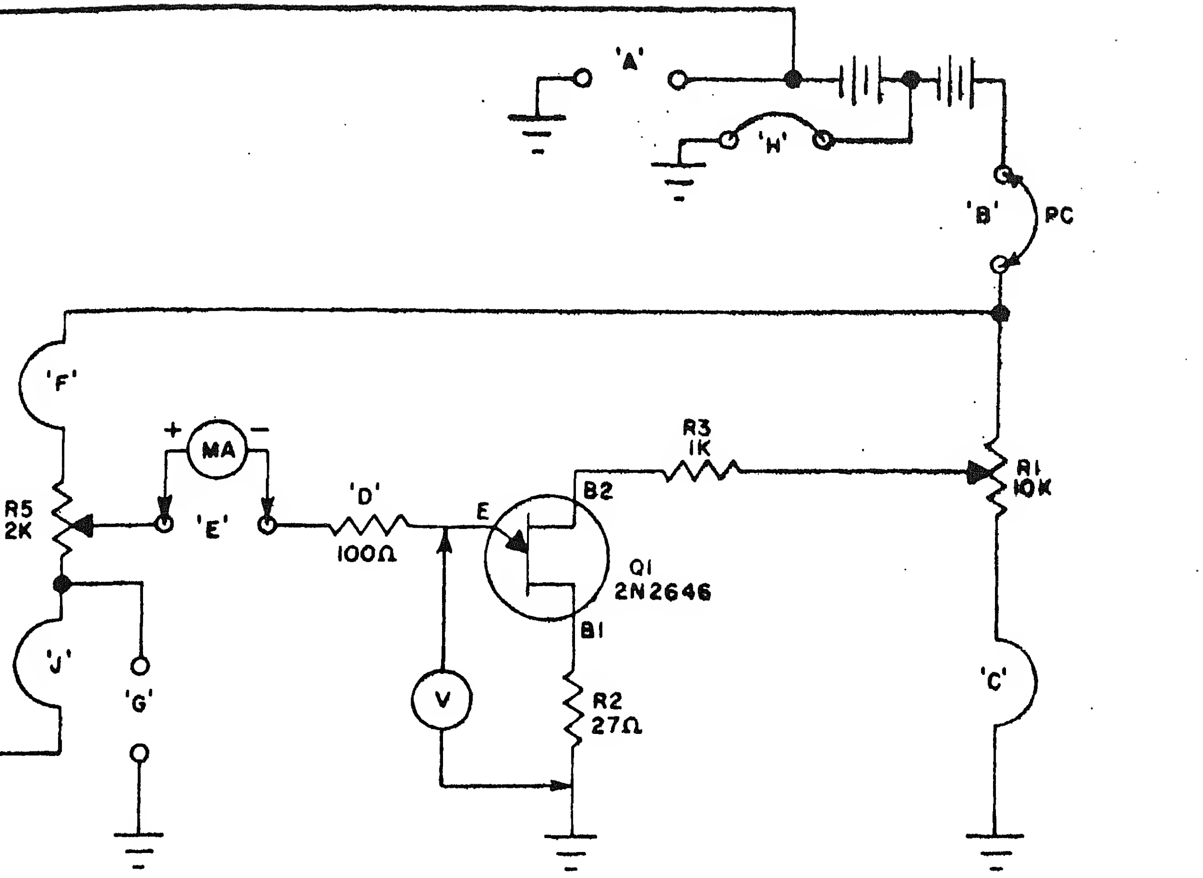
I Exercise 1 Unijunction Transistor Characteristics.

   A. PREPARATIONS:

      1. Place Template #20 on the Model 701-DCL Trainer jac field.

      2. Construct the circuit shown in Fig. 1.1.

         a. Note that for the first portion of the Exercise the center of the power supply is grounded and is connected across the entire supply.



re 1.1 Circuit for Testing Unijunction Transistor Characteristics

b. This makes it possible to apply negative bias to the UJT to check the reverse current in the emitter lead.

c. The use of a patch cord instead of a shorting strip at 'B' will make it easier to remove power from the circuit when you are making changes of components.

3. Do not apply power to the Trainer until you are instructed to do so below.

4. Test Equipment

a. Set the VOM to 50 μa scale and connect it in the circuit at 'E', using either patch cords or a 1/2-inch blank strip, whichever is more convenient.

NOTE: For the initial step, reverse the polarity of the milliammeter leads, that is, connect the negative lead to R5.

B. DC RESISTANCES IN THE 2N2646 UJT

1. Remove the 2N2646 UJT from the Trainer.

2. Identification of leads.

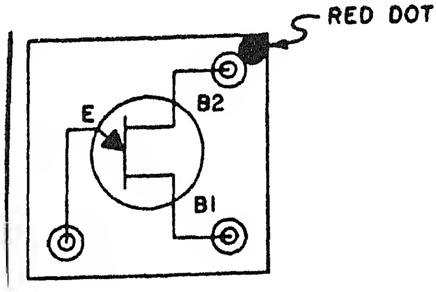


Figure 1.2. Mounting of Type 2N2646 UJT

a. When you view the UJT from the top, the leads connected as shown in Fig. 1.2.

b. Note that the emitter lead is connected to the mounting strip pin that is the base connection standard transistors.

c. Similarly, the B2 lead is connected to the coll pin, and the B1 lead is connected to the pin th is connected to the emitter of standard transis

d. The red dot on the mounting strip marks the B2 lead.

OHMMETER COMMON LEAD CONNECTED TO:	OHMMETER RESISTANCE PROBE CONNECTED TO:	RESISTANCE
B1	E	
E	B1	
B2	E	
E	B2	
B1	B2	
B2	B1	
B2	CASE (HOUSING)	
B1	CASE (HOUSING)	

Chart 1.1 UJT Resistance Measurements

3. Using the VTVM set to R x 100 scale, measure the UJT resistances listed in Chart 1.1.

4. Review your resistance measurements.

   a. Does the emitter terminal exhibit diode characteristics with respect to the B1 and B2 leads? Explain.

   b. Do the measurements of resistance between the B1 and B2 terminals confirm that these are ohmic contacts to a bar of silicon? Explain.

   c. Which terminal of the UJT is connected to the case (housing)?

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. REVERSE CURRENT IN THE EMITTER LEAD

1. Initial Adjustments.

   a. With the 2N2646 UJT still removed from the circuit, apply power to the Trainer by connecting the power cord to an a-c source.

   b. Using the VTVM/Fluke to make voltage measurements:

      (1) Adjust R5 to set the voltage at the emitter terminal at zero volts.

      (2) Adjust R1 to set the voltage at the B2 terminal at +3 volts.

   c. Remove power from the Trainer by disconnecting the power cord.

      (1) Plug in the UJT at Q1.

      (2) Apply power to the Trainer by connecting the power cord to AC.

2. Connect the VTVM to monitor emitter voltage.

3. Adjust R5 to increase the bias in the negative direction to -4 volts.

4. Is there any indication of significant reverse c

D. UJT CURRENTS

1. Initial Adjustments.

   a. Adjust R5 to set emitter voltage at zero vol

   b. Remove power from the Trainer by disconnecti power cord.

   c. Set the milliammeter to the 10 MA scale, and the leads at 'E'. The polarity should now b shown in Fig. 1.1.

   d. Apply power to the Trainer by connecting the cord to AC.

2. Emitter Currents.

   a. What is the emitter current with zero volts to the emitter?

      $V_E = 0$ V, $I_E =$ ________ma

   b. Adjust R5 to increase emitter voltage to +1

      $V_E = +1$ V, $I_E =$ ________ma

   c. With the VTVM Connected to monitor emitter v and observing the VTVM very closely, adjust slowly to increase emitter voltage to the po where 'firing' occurs.

      At firing, $V_E =$ ________volts.

      After firing, $V_E =$ ________volts.

      After firing, $I_E =$ ________ma.

   d. Adjust R5 to return V_E to zero volts.

3. B1 Currents.

   a. Preparation

      (1) Remove power from the Trainer by disconn the power cord.

      (2) Disconnect the milliammeter leads at 'E'

(3) Remove the 27 ohm resistor at R2 and plug it in at 'E'.

(4) Connect the milliammeter at R2, connecting the negative lead to ground.

(5) Apply power to the Trainer by connecting the power cord to AC.

b. What is B1 current with V_E at zero volts?

V_E = 0 V, I_{B1} = ________ma

c. Adjust R5 to increase V_E from 0V to + 1V. What is the effect on I_{B1}?

V_E = +1V, I_B1 = ________ma

d. Adjust R5 to increase V_E to the point where the UJT fires.

After firing, I_{B1} = ________ma

e. Adjust R5 to apply maximum positive bias to the emitter.

At max. bias, I_{B1} = ________ma

f. Adjust R5 to return V_E to zero volts.

4. B2 Currents

a. Connect the VTVM to monitor the voltage drop across R3.

(1) At V_E = 0V, V_{R3} = ________volts

(2) Calculate: I_{B2} = ____________ma
(Assume R3 = 1k ohms.)

b. Adjust R5 to increase bias to the point where the UJT fires.

After firing, V_{R3} = ________volts.

I_{B2} = ________ma.

c. Adjust R5 to return V_E to zero volts.

5. Before firing of the UJT, how do the B1 and B2 currents compare?

6. After firing of the UJT, how do the B1 and B2 current compare? Explain the difference.

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E. EFFECT OF V_{BB} ON FIRING POINT

1. Preparation

   a. Remove power from the Trainer by disconnecting th power cord.

   b. Remove the shorting strip at 'H' and plug it in a 'A' to ground the negative end of the power suppl instead of the center.

   c. Apply power to the Trainer by connecting the powe cord to AC.

   d. Adjust R5 to set V_E at zero volts.

   e. Connect the VTVM common lead to the B1 terminal. Leave this connected during the following steps.

2. Firing Point Voltage for V_{BB} = 4 volts.

   a. Connect the VTVM DC probe to B2. Adjust R1 to se V_{BB} at +4 volts.

   b. Connect the VTVM to E to monitor V_{E-B1}. Adjust R slowly to the point where the UJT fires, observin the VTVM closely to determine the voltage at whic firing occurs.

      (1) $V_{BB} = 4v$, V_P = ________volts.

      (2) After firing, I_{B1} = ________ma.

   c. Adjust R5 to return V_{E-B1} to zero.

3. Calculate an approximate value of the standoff ratio for $V_D = .5V$

   a. $V_P = \eta\ V_{BB} + V_D$

$$\eta = \frac{V_P - V_D}{V_{BB}}$$

b. Using the values of V_P and V_{BB} from step 2, calculate the standoff ratio. Assume that $V_D = .7v$

$$\eta = \frac{V_P - V_D}{V_{BB}} = \_\_\_\_\_\_\_\_$$

c. Using your calculated value of η, calculate V_P for $V_{BB} = 5$ volts.

$$V_P = \eta V_{BB} + V_D =$$

(Assume $V_D = .7v$)

4. Firing Point Voltage for $V_{BB} = 5$ volts.

a. Connect the VTVM DC probe to B2. Adjust R1 to set V_{BB} at +5 volts.

b. Connect the VTVM DC probe to E to monitor V_{E-B1}. Adjust R5 slowly to the firing point.

(1) $V_{BB} = 5v$, V_P = ________volts.

(2) After firing, I_{B1} = ________ma.

c. Adjust R5 to return V_{E-B1} to zero.

d. Compare the measured value of V_P to the value calculated in 3.c. above. How do they compare?

5. Firing Point Voltage for $V_{BB} = 6$ volts.

a. Using the value of standoff ratio (η) calculated in 3.b. above, calculate V_P for $V_{BB} = 6$ volts.

$$V_P = \eta V_{BB} + V_D =$$

b. Connect the VTVM DC probe to B2. Adjust R1 to set V_{BB} at +6 volts.

c. Connect the VTVM DC probe to the emitter to monitor V_{E-B1}. Adjust to R5 to increase V_{E-B1} to the firing point.

(1) V_{BB} = 6v, V_P = ________volts.

(2) After firing, I_{B1} = ________ma.

d. Adjust R5 to return V_{E-B1} to zero.

6. Review the results above.

a. How does V_P change as V_{BB} increases?

b. Does the standoff ratio appear to be constant? What is the value for the 2N2646?

c. How does I_{B1} (after firing) change as V_{BB} is increased?

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II EXERCISE 2. SCR CHARACTERISTICS

A. PREPARATIONS

1. Place Template #26 on the Model 701-DCL Trainer jackfield.

2. Construct the circuit shown in Fig. 2.1.

   a. Use patch cord at 'A'. (Not a shorting strip)

   b. Insert a shorting strip at R1.

   c. Note that R3 is connected to B+ and ground as shown in Fig. 2.1.

   d. Set the VOM to + DC, 500 MA scale and connect it at 'I', as shown. (Use patch cords or a 1-inch blank strip).

   e. Do not connect the patch cord from 'D' to the power supply '+' terminal at this time.

3. Check your circuit carefully.

B. SCR RESISTANCES

1. Remove the SCR from the cirucit. Refer to Figure 2.2.

2. Using a VOM or VTVM, measure the resistances between SCR leads as listed below. Use the scale shown. Record your results.

	Scale	Terminals	Resistance	
a.	R x 1	Anode to Case		________
b.	R x 1 MEG	Anode to Cathode	Fwd Bias	________
c.	R x 1 MEG	Anode to Gate	Rev Bias	________
d.	R x 1 MEG	Cathode to Anode	Fwd Bias	________
e.	R x 1	Cathode to Gate	Fwd Bias	________

3. Reinstall the SCR in the circuit.

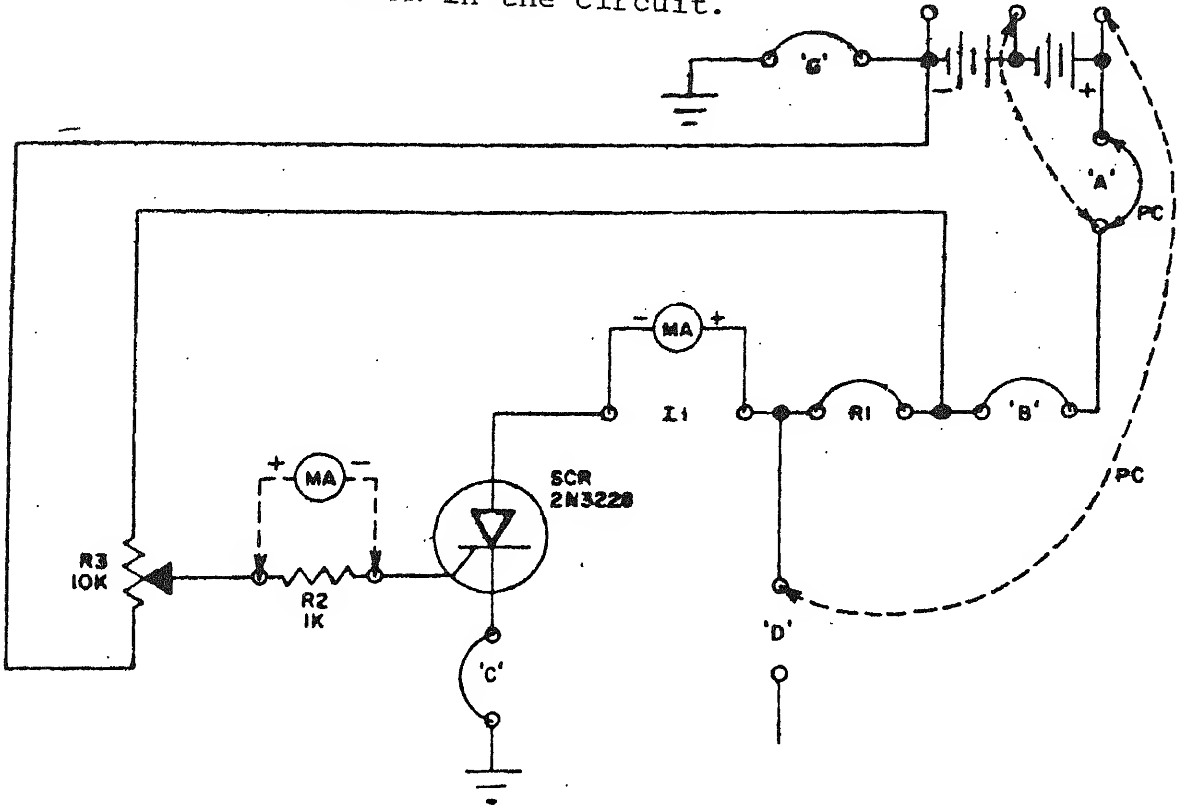

Figure 2.1. SCR Characteristics Test Circuit

C. GATE FIRING VOLTAGE

1. Preparation. (Setting Initial Bias at Zero.)

   a. Temporarily remove from the circuit the 1k resistor at R2 and the shorting strip at R1. (This disconnect power from the SCR.)

b. Connect the Trainer power cord.

c. Connect the VTVM common lead to a ground point in the circuit. Use the DC probe to measure the voltage to ground at the arm of R3.

d. Adjust R3 to set SCR gate bias at zero.

e. Remove B+ from the circuit by removing the patch cord at 'A'.

   (1) Plug in the 1k resistor at R2 and the shortin strip at R1.
   (2) Plug in the patch cord at 'A' to apply B+ to the circuit.

2. Initial Conditions

a. Note and record the indicated anode current.

At zero bias, I = __________ ma.

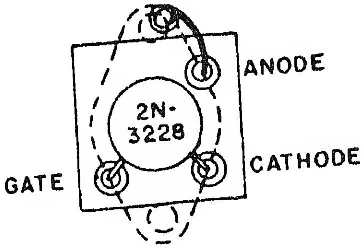

Figure 2.2 SCR Mounting, Top View

b. Using the VTVM, measure and record the voltages with respect to ground at the SCR anode and gate terminals.

At zero bias: V_{Anode} = ________V.

V_{Gate} = ________V.

c. Is the SCR conducting?

3. Measuring Gate Firing Voltage

a. Connect the VTVM DC probe to the SCR gate termina to monitor gate potential with respect to ground.

b. Observing both the VTVM and the VOM (anode current), adjust R3 carefully to increase gate potential gradually. Continue until there is a sudden increase in anode current.

c. What was the gate potential just at the point where the SCR fired?

Firing Potential, V_{Gate} = __________v.

NOTE: If you are not sure of the voltage just at the firing point, adjust R3 back to zero, remove B+ from the circuit momentarily by removing the patch cord at 'A', apply B+ by connecting the patch cord at 'A', and repeat the procedure in paragraph b. above.

4. Fired Conditions

a. With the SCR fired, measure and record the following:

(1) Anode voltage: V_{Anode} = __________V.

(2) Gate voltage: V_{Gate} = __________V.

(3) Anode current: I_{Anode} = __________ma.

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TURNING OFF THE SCR

1. Effect of Gate Potential

a. With the SCR fired, adjust R3 to apply maximum positive bias to the gate.

(1) Note the anode current.

At maximum forward bias, I_{Anode} = __________ma.

(2) Did increasing gate bias to maximum affect anode current significantly?

b. Adjust R3 to reduce forward bias to zero.

(1) Note SCR anode current.

At zero bias, I_{Anode} = __________ma.

(2) Did reducing bias to zero turn off the SCR?

2. Effect of lowering Anode Voltage.

   a. Remove the patch cord at 'A', then replace the patch cord.

      (1) What happened to anode current?

      I_{Anode} = __________ma.

      (2) Measure anode voltage,

      V_{Anode} = __________V.

      (3) Is the SCR back in the 'blocked' or 'OFF' condition?

   b. Adjust R3 to increase bias to the point where the SCR fires again.

      (1) Leaving R3 set at this point, remove the patc cord at 'A', then replace the patch cord at 'A'.

      (2) What happens to the SCR? Is it cut off or conducting? Why?

      (3) Adjust R3 to set bias at zero. Now remove th patch cord at 'A' and then replace the patch cord. The SCR should cut off.

3. Effect of Reducing Anode Current.

   a. Preparations

      (1) Remove the shorting strip at R1.

      (2) Plug in a 390-ohm resistor at R1.

      (3) Connect a patch cord from the upper jack at ' to the '+' terminal of the power supply. (Se the dotted line in Fig. 2.1.) Note that this patch cord shorts out the 390-ohm resistor at R1.

   b. Effect of a 390-ohm anode resistor.

      (1) Connect the VTVM to monitor anode voltage.

      (2) Adjust R3 to increase bias until the SCR swit on. Record anode voltage and current.

      V_{Anode} = __________V.

      I_{Anode} = __________ma.

(3) Remove the patch cord connecting 'D' to '+'. Note and record anode voltage and current.

V_{Anode} = __________ V.

I_{Anode} = __________ ma.

(a) Compare this anode current to the one recorded in (2) above.

(b) Has anode current changed? Why? Is the SCR still 'ON'?

(4) Adjust R3 to reduce gate bias to zero.

(a) Note and record anode voltage and current.

V_{Anode} = __________ V.

I_{Anode} = __________ ma.

(b) Is the SCR still turned 'ON'?

c. Effect of a 2.2kΩ anode resistor.

(1) Remove the 390-ohm resistor at R1.

(2) Plug in a 2.2kΩ resistor at R1.

(3) The SCR should be 'OFF' (blocked), as indicated by anode voltage and current.

(4) Plug in the patch cord from 'D' to '+' to short out the 2.2K resistor at R1.

(5) Adjust R3 to increase gate bias until the SCR fires. Leave R3 at this setting. Record anode voltage and current.

V_{Anode} = __________ V.

I_{Anode} = __________ ma.

(6) Remove the patch cord from 'D' to '+', thus putting the 2.2K resistor in the anode circuit.

(a) Record anode voltage and current.

V_{Anode} = __________V.

I_{Anode} = __________ma.

(b) Have anode voltage and current changed? Is the SCR still on?

(7) Adjust R3 to reduce gate bias to zero.

(a) Record anode voltage and current.

V_{Anode} = __________V.

I_{Anode} = __________ma.

(b) Is the SCR still conducting? If not, why not?

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E. RATIO OF SWITCHED CURRENT TO SWITCHING CURRENT

1. Preparation

   a. Remove the 2.2kΩ resistor at R1.

   b. Plug in a shorting strip at R1.

   c. The SCR should be switched 'Off'.

2. Measure the Controlled (Switched) Current

   a. Adjust R3 to increase gate bias until the SCR fires. Record anode current.

   I_{Anode} = __________ma.

3. Measure the Controlling (Switching) Current.

   a. Preparation

   (1) Adjust R3 to set gate bias at zero.

   (2) Remove the patch cord at 'A' to remove B+ from the circuit.

(3) Remove the 1k resistor at R2.

(4) Disconnect the milliammeter leads at I_1 and connect in place of R_2 in Fig. 2.1. Set the milliammeter to the 10 MA scale.

(5) Plug in a shorting strip at I_1.

(6) Connect the VTVM to monitor anode voltage.

(7) Connect the patch cord at 'A' to apply B+ to the circuit.

(8) The SCR should be 'Off', as indicated by anode voltage.

b. Adjust R3 to increase gate bias slowly to the point where the SCR fires (as indicated by anode voltage). Note and record gate current just at the firing point (not after firing).

I_{Gate} = __________ma.

4. Calculate the ratio of switched (anode) to switching (gate) current.

$$\text{Ratio} = \frac{I_{Anode}}{I_{Gate}} = \underline{\qquad\qquad} =$$

5. Effect of Anode Voltage on Switching Current

a. Adjust R3 to set gate bias at zero.

b. Remove the 'B'+ end of the patch cord at 'A'. Now plug this end of the patch cord into the center terminal of the power supply, thus applying 4-volt power to the circuit. (See the dotted line connection in Fig. 2.1.

c. The SCR should be 'Off'.

d. Connect the VTVM to monitor anode voltage.

e. Observing gate current, adjust R3 to increase gate bias to the point where the SCR fires. Record the gate current just at the firing point (before firing).

I_{Gate} = __________ma.

(1) Compare this current to the gate current recorded in 3.b. above.

(2) Has the reduction of anode voltage from 8v t
4v (approximately) changed the gate current
required to fire the SCR?

(3) Do your results suggest that firing current i
relatively independent of anode voltage and
therefore is independent of anode (switched)
current?

(4) Suppose that the SCR were rated at 2a maximu
anode current. What would the switching rati
be if the SCR switched on with Ig as measure
in 5.e. of preceding page.

$$\text{Ratio} = \frac{2a}{\qquad\qquad} =$$

F. SCR APPLICATION

1. Preparation

   a. Adjust R3 to set gate bias at zero.

   b. Disconnect the end of the 'A' patch cord from th
   power supply center terminal.

   c. Remove the shorting strip at I_1.

   d. Plug in the incandescent lamp (G.E. type #502) a
   I_1.

   e. Disconnect the milliammeter leads at R2.

   f. Plug in a 1k resistor at R2.

2. Turning on the lamp.

   a. Connect the patch cord at 'A' to apply B+ (8v) t
   the circuit.

   b. Connect the VTVM to monitor anode voltage.

   c. Adjust R3 to increase gate bias until the SCR
   fires, as indicated by a drop in anode voltage.
   The lamp should be lighted.

3. Controlling Lamp Brilliance

   a. Adjust R3 to vary bias from minimum to maximum. Does this affect lamp brilliance? Why?

   b. Set R3 to apply zero gate bias.

4. Turning the Lamp Off.

   a. Remove the patch cord at 'A', then connect the patch cord at 'A' again. The lamp should be turned off.

   b. Repeat steps 2 and 4 to observe control of the lamp.

5. Disconnect the Trainer power cord. Return all components to storage.

G. CONCLUSIONS

1. What gate potential and gate current were required to 'fire' the SCR?

2. Define 'holding current' and 'holding voltage' as applied to an SCR.

3. How can you return the SCR to the blocked (off) condition after it has been turned on?

4. What was the ratio of controlled current to controlli
current for this SCR in this circuit?

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III EXERCISE 3. UJT TRIGGERING OF THE SCR

A. PREPARATIONS:

1. Place Template #28 on the Model 701-DCL Trainer jackfield.

2. Construct the circuit shown in Fig. 3.1.

   a. For this Exercise, connect C1 with the positive side grounded, negative side connected to R1 and 'A'.

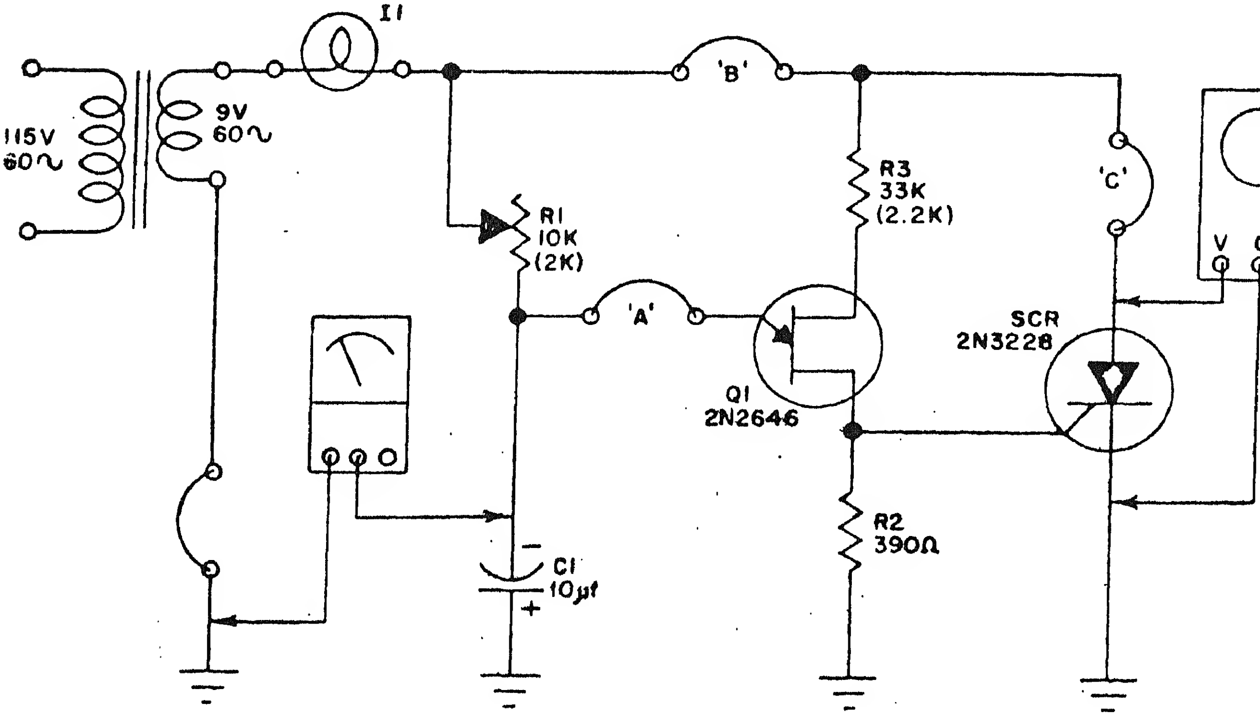


Figure 3.1. UJT Firing SCR

3. Test Equipment

   a. Connect VTVM and oscilloscope ground leads to ground points in the circuit.

   b. Set the VTVM to -DC 5v scale and connect the DC probe to the shorting strip at 'A' to monitor the voltage across C1.

   c. Connect the oscilloscope Vertical input probe to monitor SCR anode voltage waveform.

   d. Turn on the VTVM and oscilloscope to allow warm-up.

4. Check your circuit and test equipment connections.

5. Connect the Trainer power cord.

B. SURVEY OF OPERATION

1. Adjust R1 to vary lamp intensity slowly from maximum intensity to the 'Off' condition, observing at the same time the effect on SCR anode waveform.

   a. Through how many degrees of the a-c waveform can you vary SCR firing?

   b. How does this control compare to the control provided by the D-C circuit in the preceding Exercise?

2. Effect of Changing Circuit Components.

   a. Preparation

      (1) Disconnect the Trainer power cord.

      (2) Replace the 33k resistor at R3 with a 2.2kΩ resistor.

      (3) Replace the 10k potentiometer at R1 with a 2k potentiometer.

      (4) Connect the Trainer power cord again.

   b. Adjust R1 to vary lamp intensity from maximum intensity to 'Off', observing also the effect on the SCR anode waveform.

c. Compare the control provided by this circui that provided by the original circuit, espe all low levels of lamp intensity.

C. WAVEFORMS AND VOLTAGES

1. SCR Firing near 180°.

   a. Adjust R1 until the SCR is not firing, as i by an unbroken sine wave at the SCR anode.

   b. Turn R1 back until the SCR just starts to f near the 180° point on the anode waveform.

   c. What is the condition of the lamp? Why?

   d. Sketch two cycles of the observed SCR anode in section 1.a. of Chart 3.1. Indicate the peak-to-peak amplitude.

   e. Connect the oscilloscope to R2 to observe t gate (and UJT B1) waveform.

      (1) Sketch two cycles of the SCR gate wavef section 1.b. of Chart 3.1, showing it i phase relation to the anode waveform.

      (2) Indicate the peak-to-peak amplitude.

   f. Note the dc voltage across C1. Record this Chart 3.1.

2. SCR Firing near 90°.

   a. Connect the oscilloscope Vertical input pro the shorting strip at 'C' to observe the SC waveform.

b. Adjust R1 to advance the firing of the SCR so that it fires at the peak (90° point) of the applied sine wave.

c. What is the condition of lamp I_1?

d. Note the dc voltage across C1. Record the measured voltage in Chart 3.1.

e. In section 2 of Chart 3.1, sketch two cycles of the SCR anode waveform (section 2a) and two cycles of the SCR gate waveform (section 2b), showing them in correct phase relation to each other and to the waveforms in section 1. Indicate the amplitudes of each waveform.

SCR Firing near 0°.

a. Connect the oscilloscope Vertical input probe to monitor the SCR anode waveform.

b. Adjust R1 to advance SCR firing until it is firing near the 0° point on the applied waveform.

c. What is the condition of lamp I_1?

d. Record in Chart 3.1 the measured level of dc voltage across C1.

e. In section 3 of Chart 3.1, sketch two cycles of the SCR anode waveform and of the SCR gate waveform, showing them in correct phase relation to each other and to the other waveforms. Indicate the amplitudes.

____________ Instructor Initial

ECK OF CIRCUIT STABILITY

Initial Settings

a. Connect the oscilloscope to monitor the SCR anode waveform.

1. SCR FIRING NEAR 180°

a. ANODE

V_{C1} = ______ V, dc

b. GATE

2. SCR FIRING AT 90°

a. ANODE

V_{C1} = ______ V, dc

b. GATE

3. SCR FIRING NEAR 0°

a. ANODE

V_{C1} = ______ V, dc

b. GATE

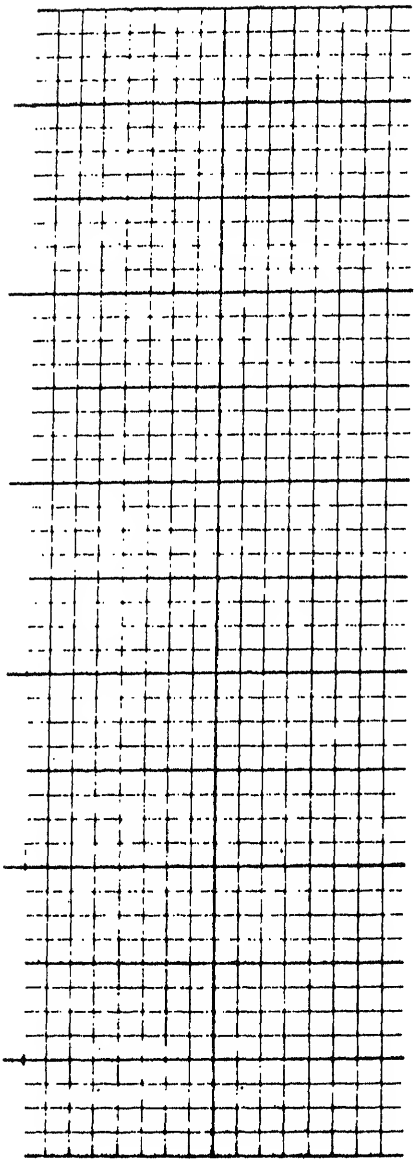


Chart 3.1. SCR Waveforms with UJT Firing

b. Adjust R1 to retard SCR firing until the SCR is just firing near the 180° point on the applied waveform. (The SCR anode waveform should be the same as that sketched in section 1.a. of Chart 3.1.)

2. Changing the Circuit

   a. Disconnect the Trainer power cord.

   b. Remove the shorting strip at 'D'.

   c. Plug in a 27-ohm resistor at 'D'.

   d. Connect the Trainer power cord.

3. Comparison of Waveforms

   a. If the SCR is not firing, adjust R1 just enough to obtain the same anode waveform as you had in step 1.b.

   b. Is it necessary to adjust R1 very far to obtain the same firing?

4. Disconnect the Trainer power cord. Secure all equipment.

CONCLUSIONS

1. Compare the UJT/SCR circuit to the SCR only circuit with regard to smoothness of control.

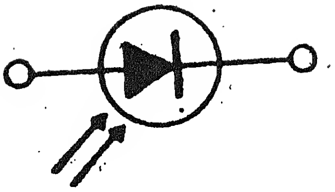
2. What are the advantages of using a UJT to control firing of the SCR?

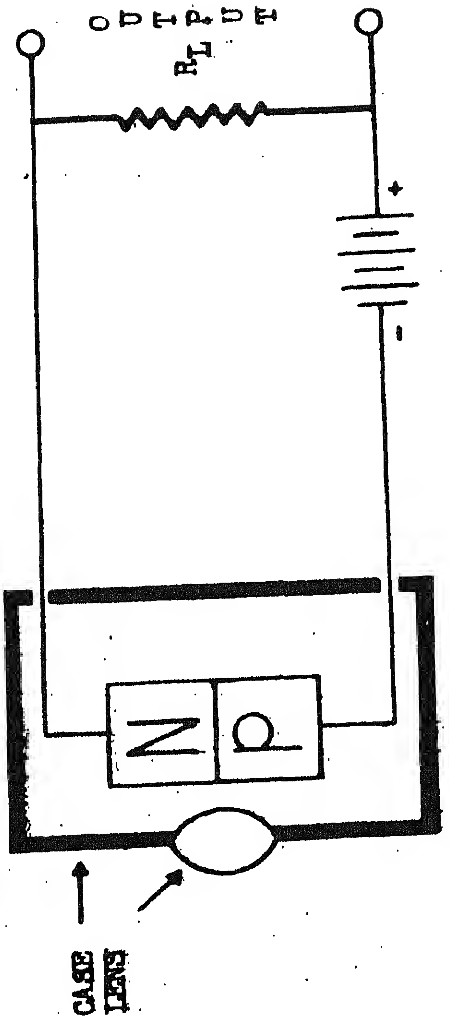
3. What type of circuit would you use to couple the B1 terminal of the UJT to the SCR gate if it were desi to trigger the SCR with a spike only?

4. If variable dc were applied to the UJT emitter (ins of AC), what range of control could be obtained (ho many degrees)? Explain.

______________________Instructor Initial

DIAGRAM SHEET FOR
LESSON TOPIC 5.3





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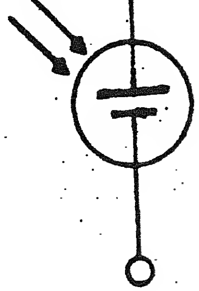
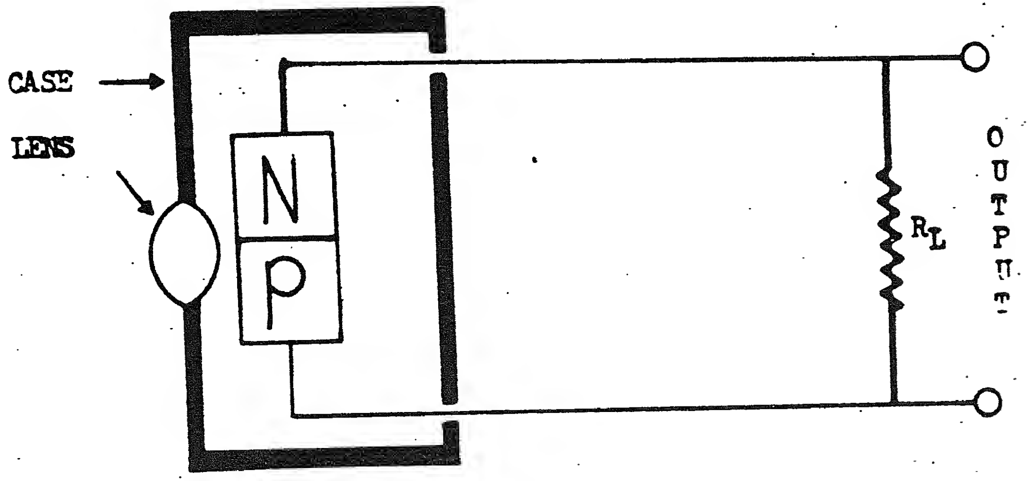




PHOTOVOLTAIC CELL

FIGURE 2

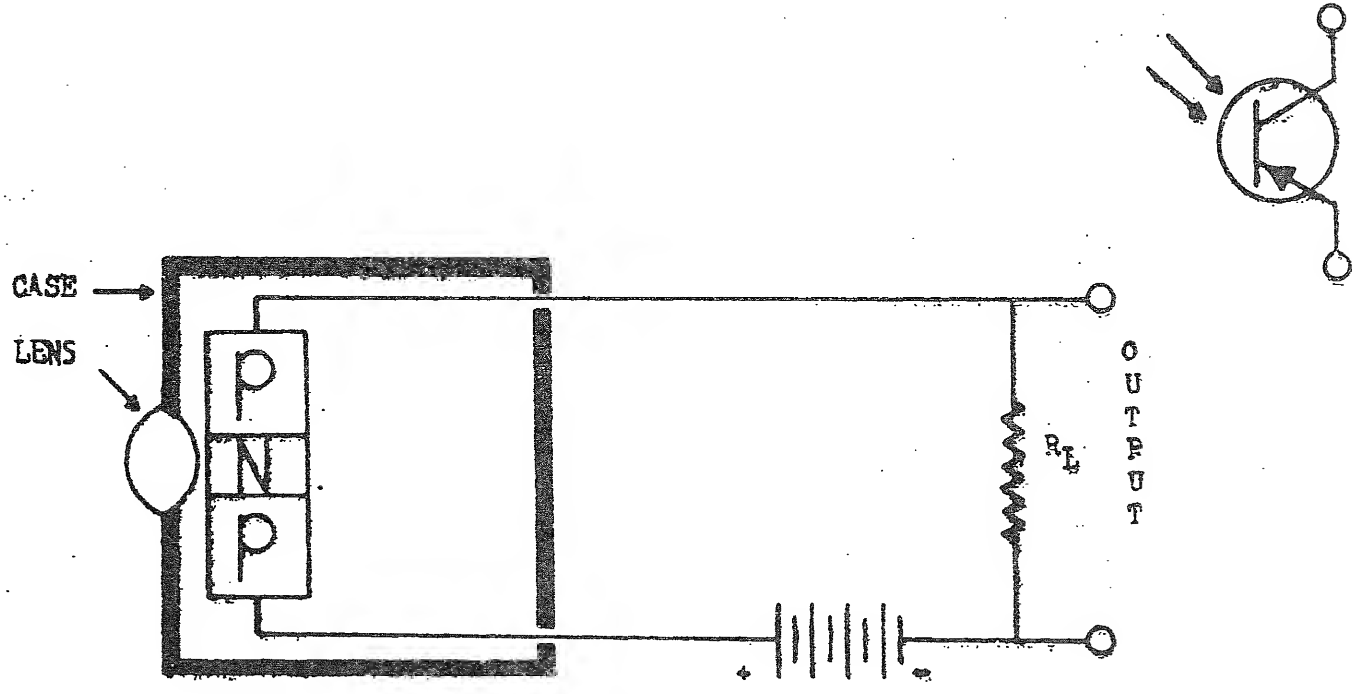
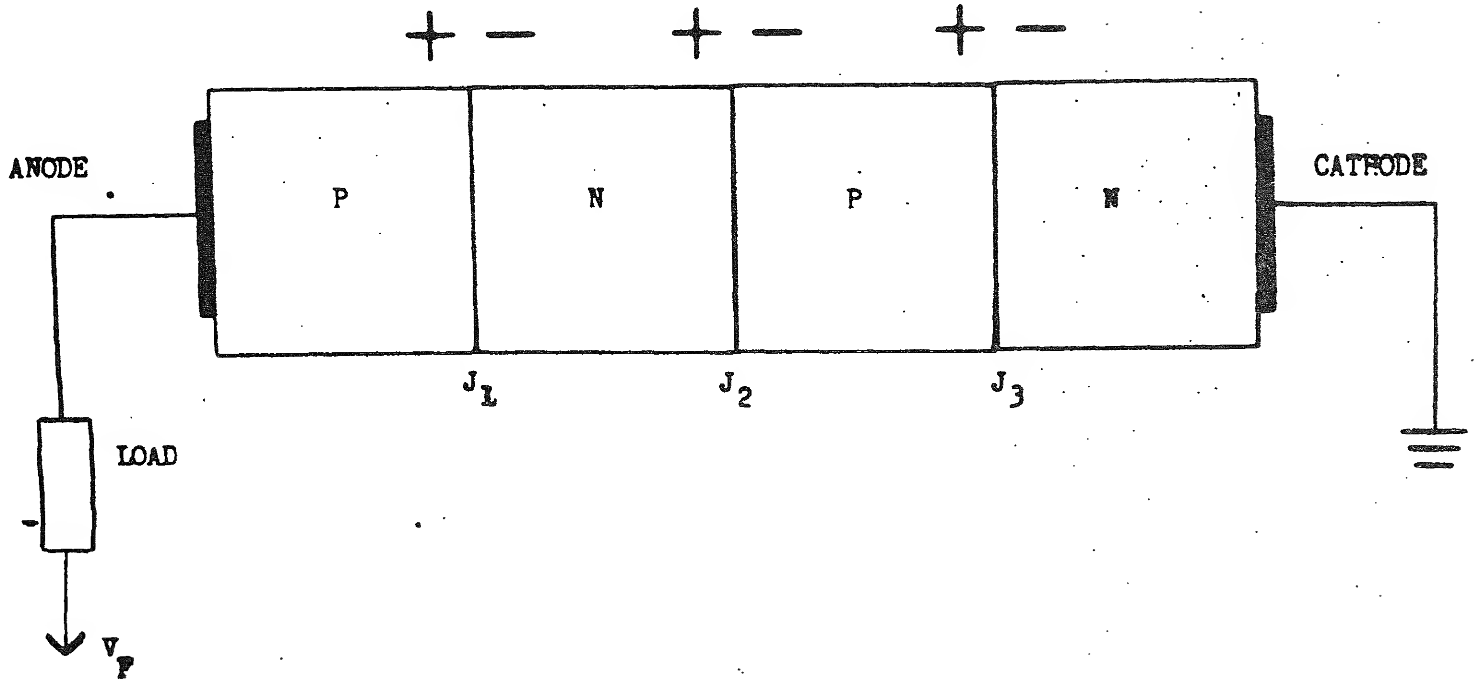


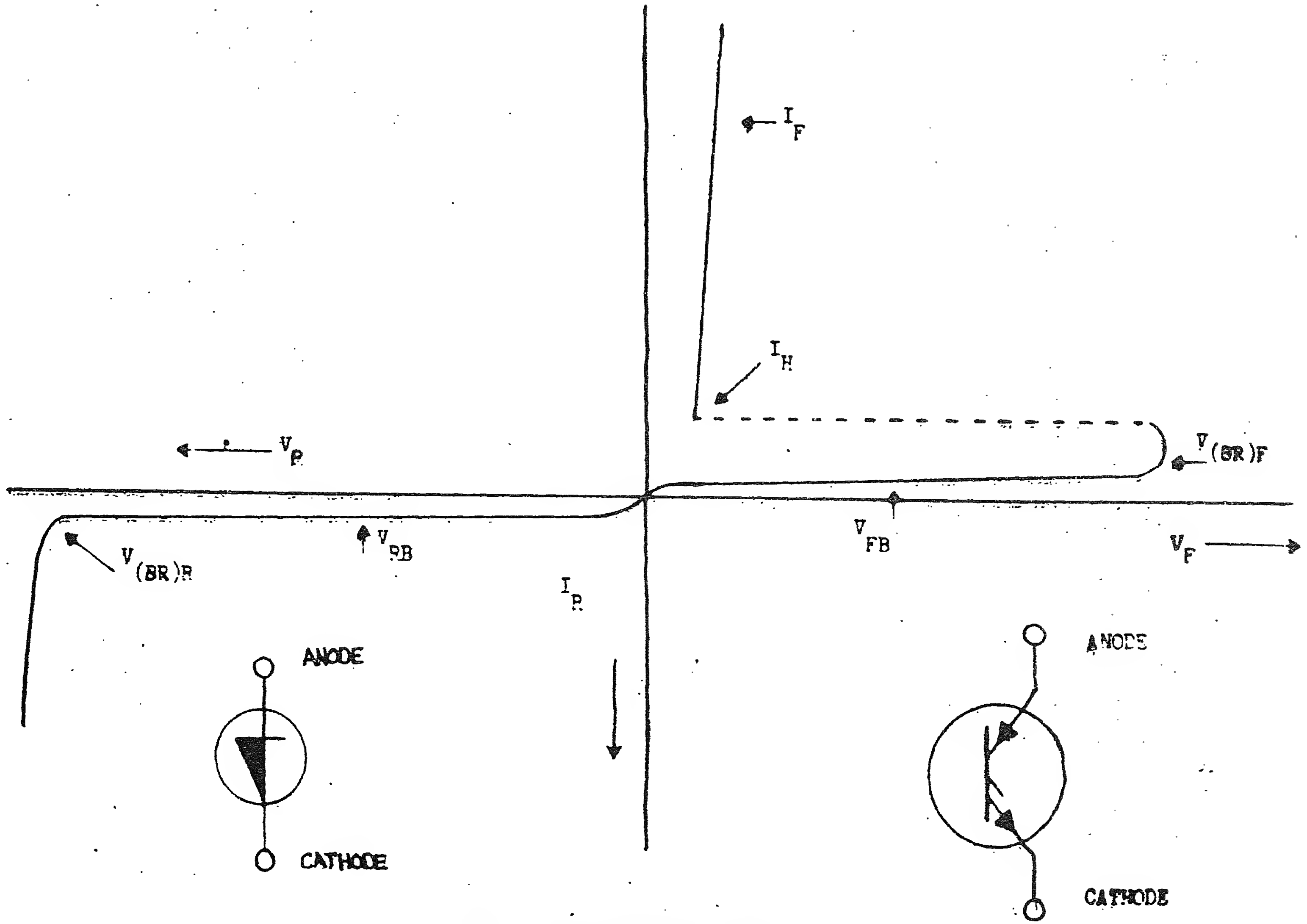
PHOTO TRANSISTOR

FIGURE 3



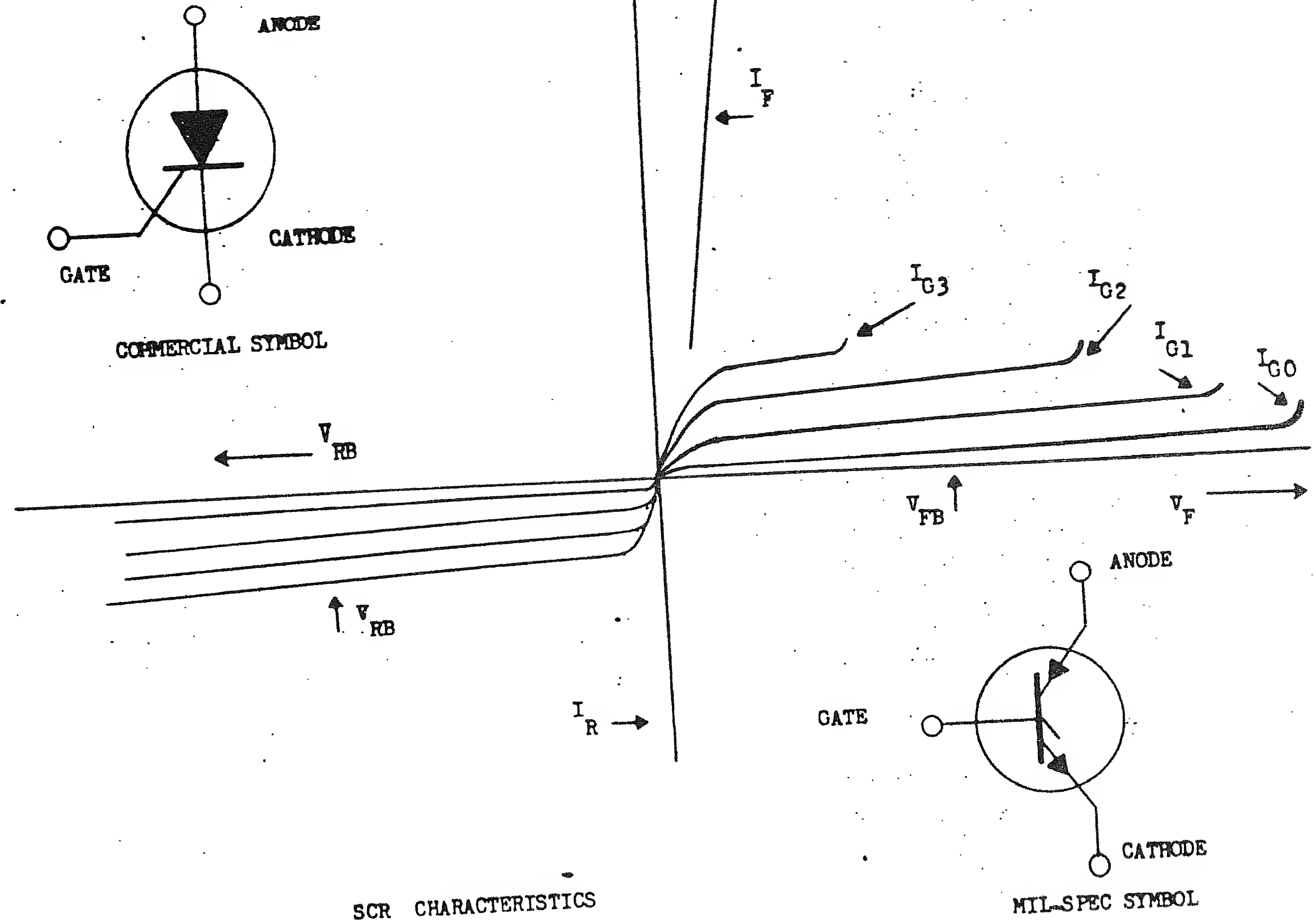
PNPN STRUCTURE

FIGURE 4



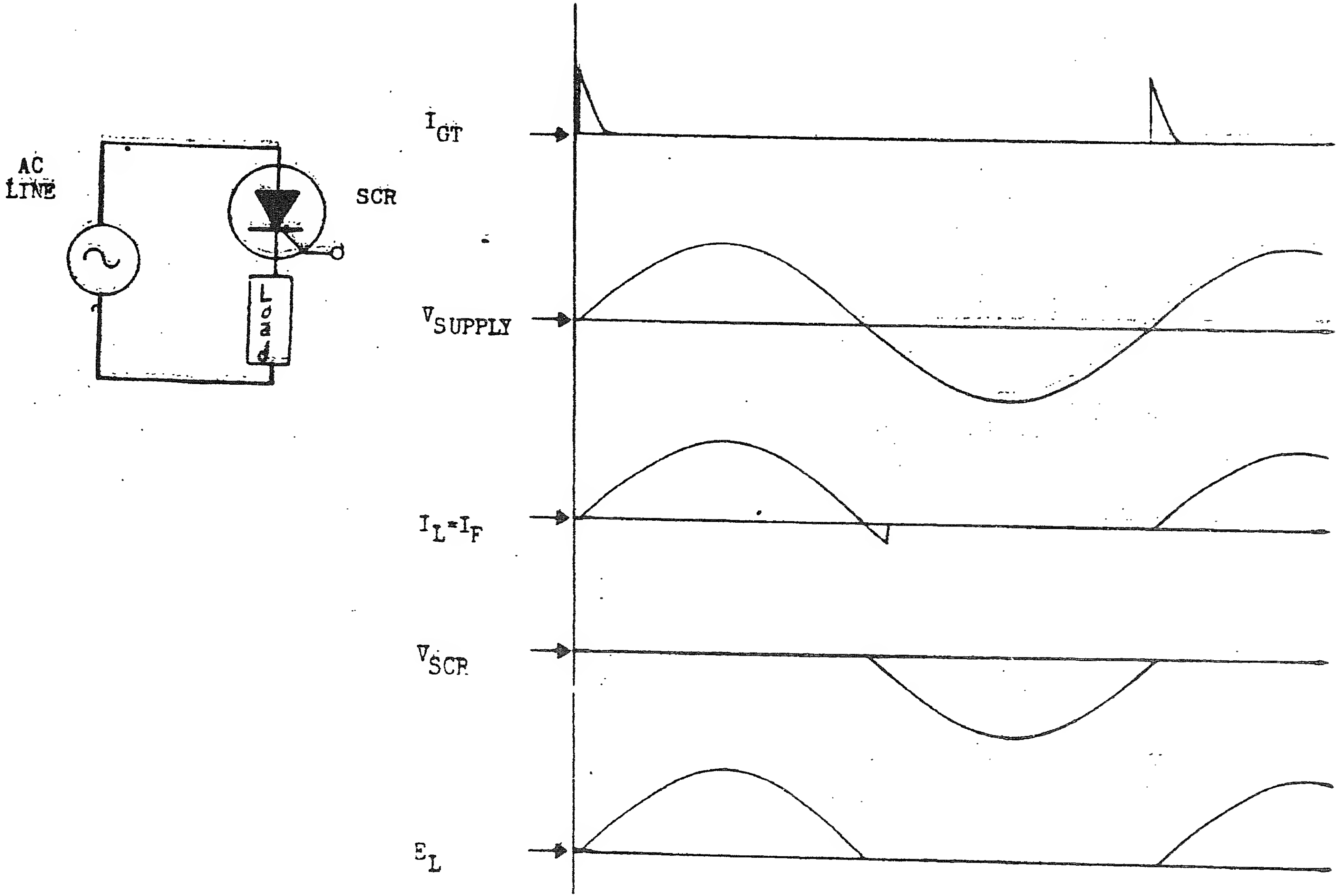
PNPN CHARACTERISTIC GRAPH

Figure 5

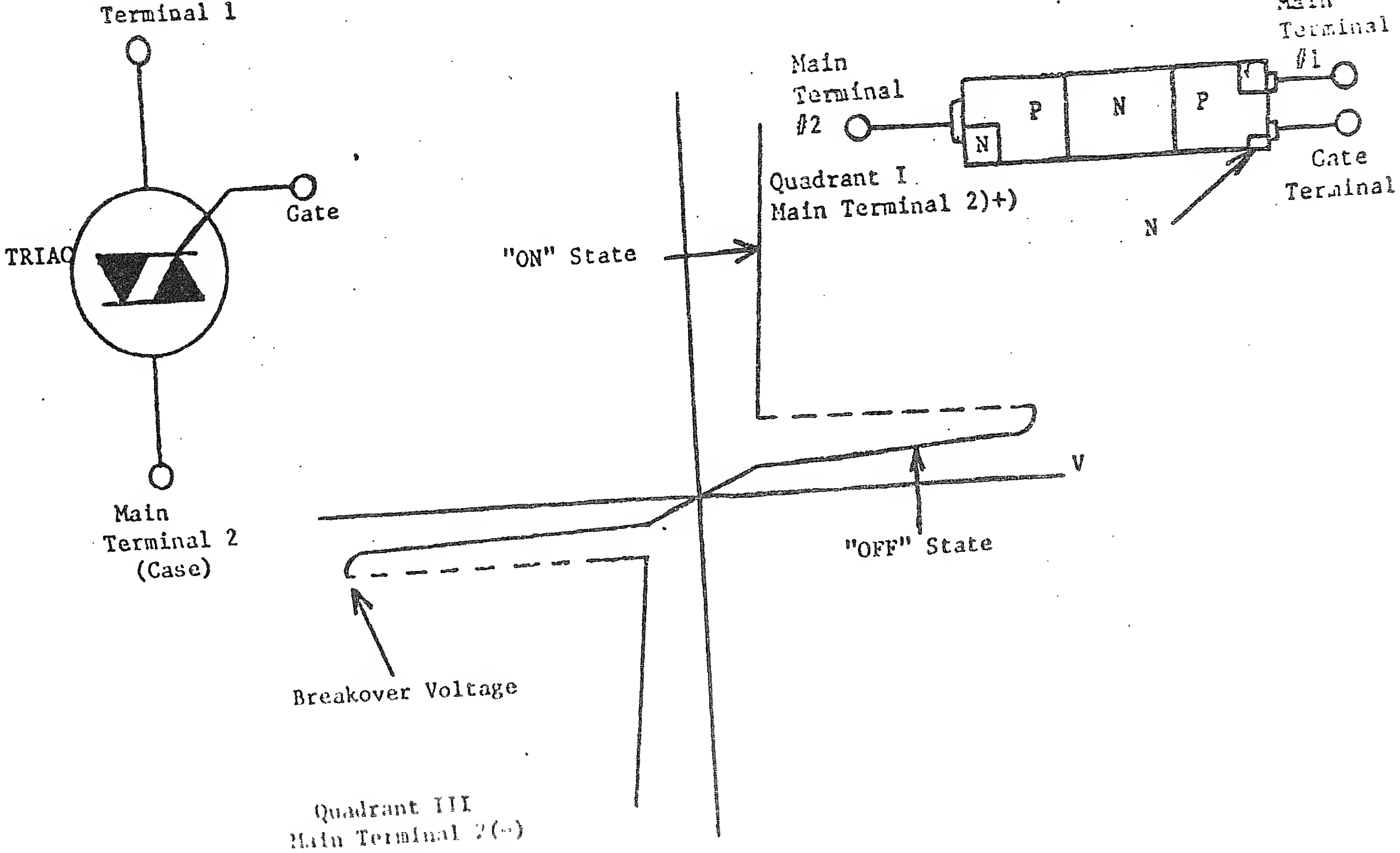


SCR CHARACTERISTICS

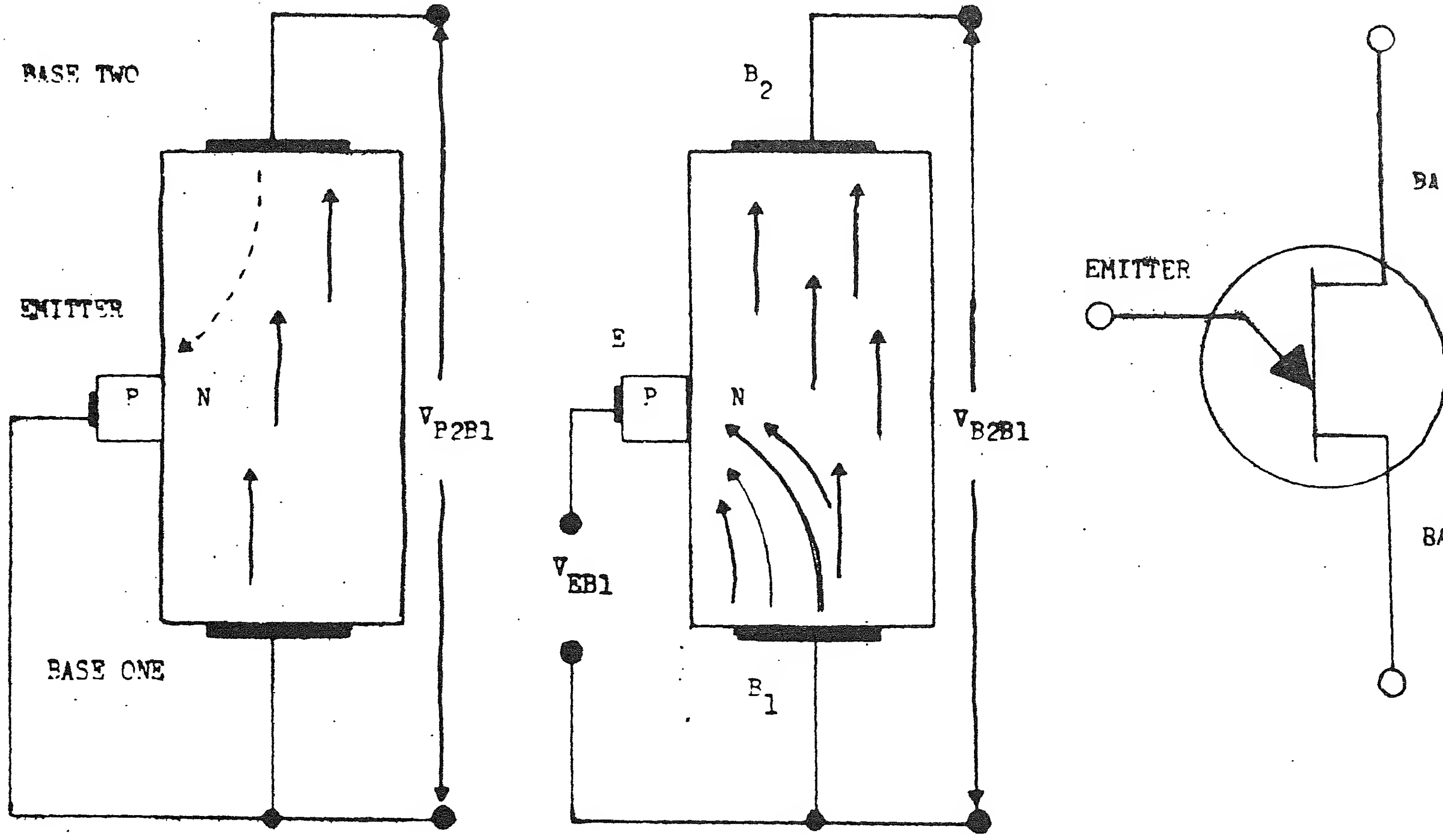
FIGURE 6



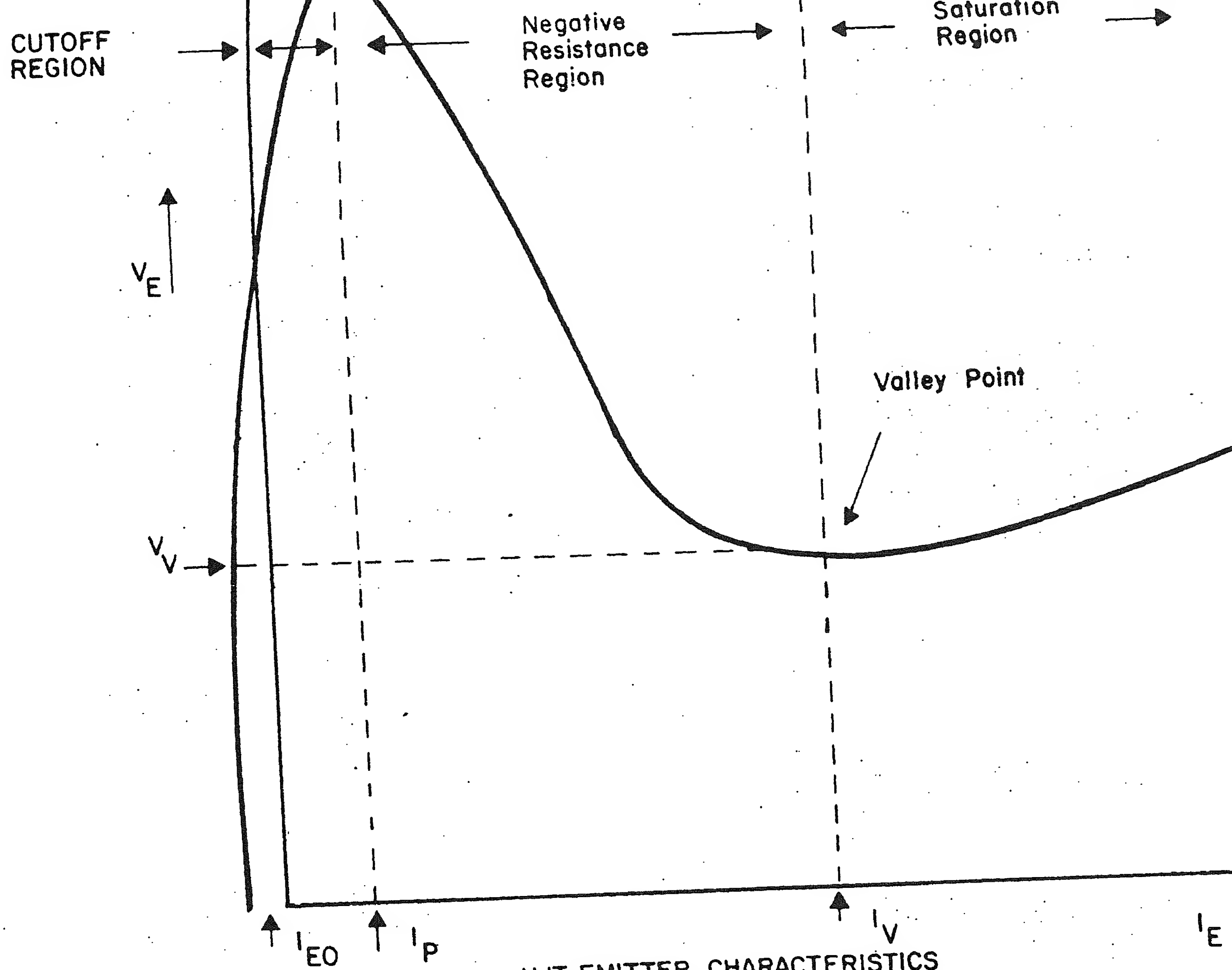
SCR APPLICATION



Terminal 1
Gate
TRIAC
Main Terminal 2 (Case)
"ON" State
Quadrant I Main Terminal 2)+)
V
"OFF" State
Breakover Voltage
Quadrant III Main Terminal 2(-)
Main Terminal #2
P
N
P
N
Main Terminal #1
Gate Terminal
N

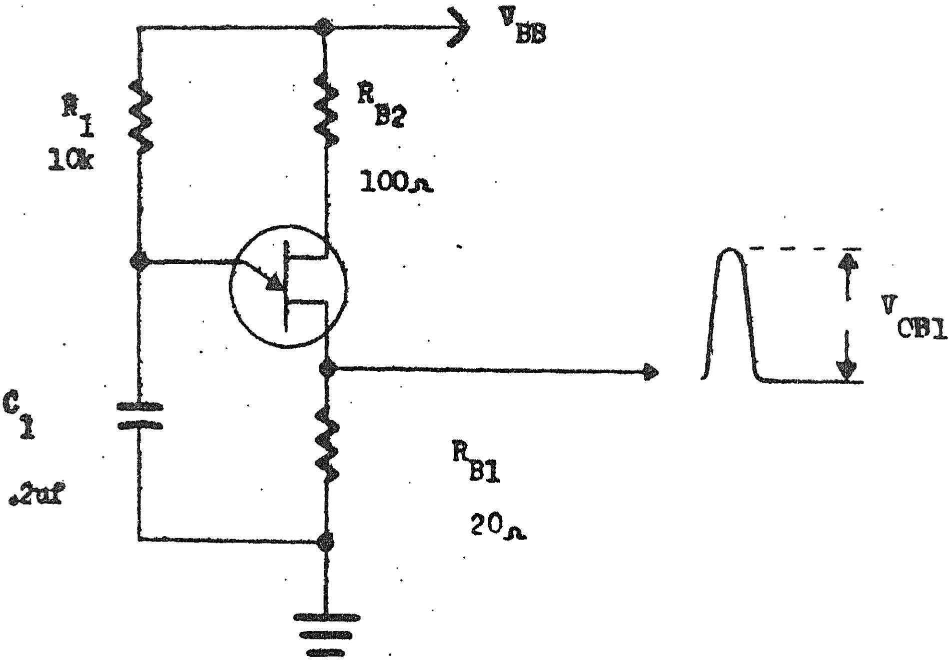


SILICON UNIJUNCTION TRANSISTOR



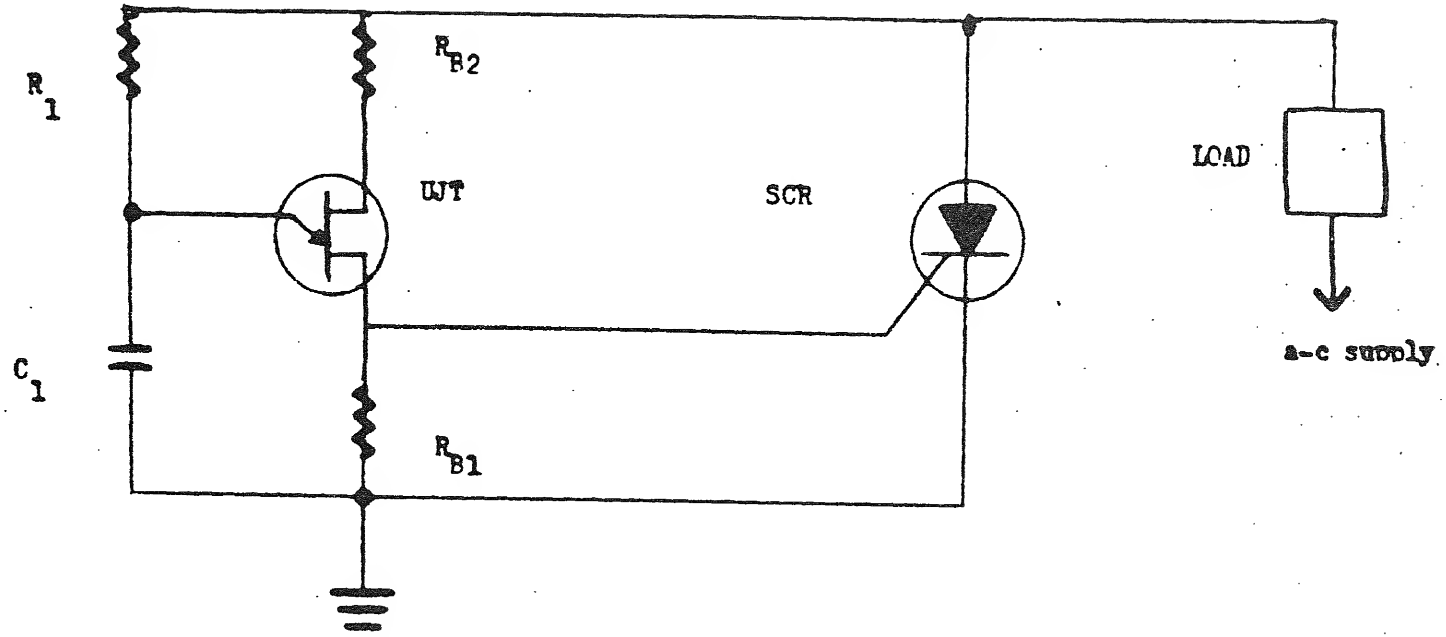
UJT EMITTER CHARACTERISTICS

FIGURE 10



UJT CIRCUIT

FIGURE 11



UJT CONTROL OF AN SCR

FIGURE 12

INTRODUCTION: This assignment will provide problems which di relate to the learning objectives listed below. you can accomplish this assignment you have met requirements of the learning objectives. It is recommended that you answer these questons with same materials as those you will have when tak the progress test. In this way, you will be te yourself.

ENABLING OBJECTIVES:

5.4.1 Given a list of statements concerning Thermionic emiss select the statement which correctly describes the "wo function" of a material.

5.4.2 Given a list of statements concerning thermionic emiss select the statement which correctly describes "space charge".

5.4.3 Given a list of statements concerning vacuum diodes se the statement which correctly describes the device.

5.4.4 Given a list of diode ratings and a list of descriptive statements match each rating to the statement which de it.

5.4.5 Given specifications or graphical data concerning a va diode calculate both the d.c. and the a.c. plate resis at a specified operating point.

5.4.6 Select from a group of drawings the drawing which graph ically depicts the general current-voltage characteris of gas filled diodes.

5.4.7 Select from a list of statements concerning electrosta the statement which describes why a multi-element vacu tube can function as an amplifier.

5.4.8 Given a list of statements concerning the tetrode vacu tube, and a current-voltage graph of a tetrode vacuum select the statement which correctly describes why tet are best suited as class B and class C power amplifier

5.4.9 Given a list of statements concerning the pentode vacu tube, select the statement which correctly describes t function of the suppressor grid.

5.4.10 Given a list of common vacuum tube parameters and a li descriptive statements, match each parameter to the st ment which describes it.

depicts a triode vacuum tube connected to function as a comcom cathode, class A, RC coupled amplifier.

4.12 Select from a group of drawings the drawing which correctly depicts a triode vacuum tube connected to function as a class A common grid (grounded grid) transformer coupled amplifier.

4.13 Select from a group of drawings, the drawing which correctly depicts a pentode vacuum tube connected to function as a class A, common cathode, RC coupled amplifier.

4.14 Select from a list of statements concerning RF amplifiers the statement which correctly describes the purpose of neutralization.

4.15 Given a list of statements concerning inter-electrode transit time, select the statement which correctly describes the effect of electrode spacing on upper frequency limits of vacuum tubes.

UDY ASSIGNMENT:

Read: NEETS Module 6, Electronic Emission, Tubes and Power Supplie
NAVEDTRA 172-06-00-82

Complete: Student Activity Guide 5.4.1S

UDY QUESTIONS:

1. At frequencies below 30 MHz pentodes are preferred over triodes; why?

2. Given a 500,000 watt RF amplifier, state some possible consequences of oscillation due to improper neutralization.

3. In UHF RF amplifiers, why are some capacitors and inductors which are shown on the schematic difficult (or impossible) to locate.

4. When a moving electron enters a retarding electric field does it give up energy to the field or absorb energy from it?

5. Which tube has the lowest noise factor: (1) triode? (2) pentode?

6. Consider a commercial broadcast tube with a rated output of 50 kW. Why couldn't we have a "transistor" capable of producing this level of RF power?

7. Is there any type of circuit in which the plate is operated at a potential which is less than that of the screen or suppressor?

STUDENT ACTIVITY GUIDE 5.4.1S
VACUUM TUBE AMPLIFIERS

1. Thermionic emmission is the process of the liberation of electrons from a metal by

   a. light falling upon the surface of the material.
   b. electrons pulled from a material by a high positive electrical voltage.
   c. bombardment of a surface by fast-moving electrons.
   d. increasing the energy of electrons by heat.

2. Indirectly heated cathodes are used instead of directly heated cathodes in an a-c receiver because they

   a. consume less power.
   b. operate at lower temperatures.
   c. reduce hum.
   d. use less wire.

3. When the plate of a diode is made positive with respect to the cathode, the diode will conduct.

______a. True
______b. False

4. When the plate of a diode is made positive with respect to the cathode, the space charge is immediately dissipated.

______a. True
______b. False

5. The d-c plate resistance of a tube is designated a r_p.

______a. True
______b. False

6. A gas molecule that loses one electron is called a

______a. double ion.
______b. negative ion.
______c. positive ion.
______d. free electron.

7. The positive ion positions near the

______a. plate.
______b. positive element.
______c. getter.
______d. negative element.

. A gas tube remains in conduction until the

_____a. striking potential is reached.
_____b. applied voltage falls below an acceptable minimum.
_____c. ionizing level is reached.
_____d. bias cuts the tube off.

. Triodes differ from diodes in that

_____a. triodes are always indirectly heated filament-type tubes.
_____b. triodes can be used to amplify small electrical signals.
_____c. there are no electrostatic fields within a triode.
_____d. diodes contain an anode, cathode, and grid.

. All d-c electrode voltages of the triode are measured with respect to

_____a. chassis ground.
_____b. the tube's plate.
_____c. the cathode of the tube.
_____d. the grid.

. The amplification factor is

_____a. the amount of amplification a tube will produce under all conditions.
_____b. an indication of the amount of control the plate voltage has over plate current.
_____c. an indication of how much greater control the grid voltage has on plate current than does the plate voltage.
_____d. not dependent upon the geometric structure of the tube.

. What is the amplification factor of a tube in which a plate voltage change of 5 volts is offset by a grid voltage change of .25 volt?

_____a. 2.
_____b. 12.5.
_____c. 30.
_____d. 20.

13. The a-c plate resistance of a tube is

______a. an indication of the resistance to changes in plate current.
______b. the tube's resistnace to the conduction of d-c plate current.
______c. a ratio of a small change in plate current as caused by a small change in grid voltage with plate voltage constant.
______d. a pure number and has no reference to any units.

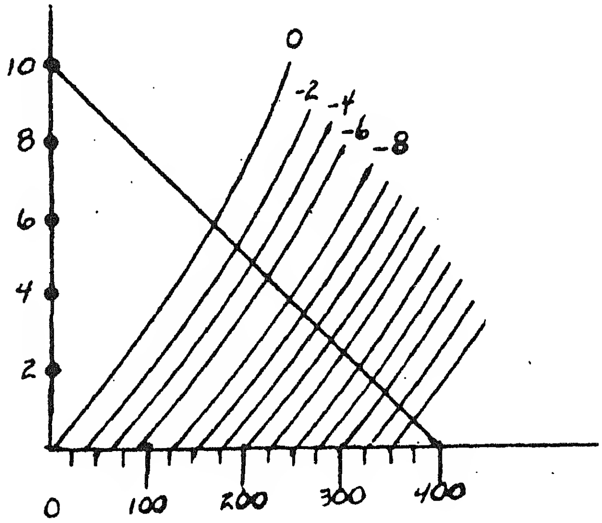
14. Amplification factor varies

______a. indirectly with plate voltage.
______b. directly with the grid-to-cathode spacing.
______c. directly with grid voltage.
______d. directly with the grid-to-plate spacing.

15. The indication of the amount of control the grid voltage has over plate current is known as

______a. amplification factor.
______b. transconductance.
______c. a-c plate resistance.
______d. figure of merit.

16. In figure 1, what is the plate current when the operatin bias is -8 volts?

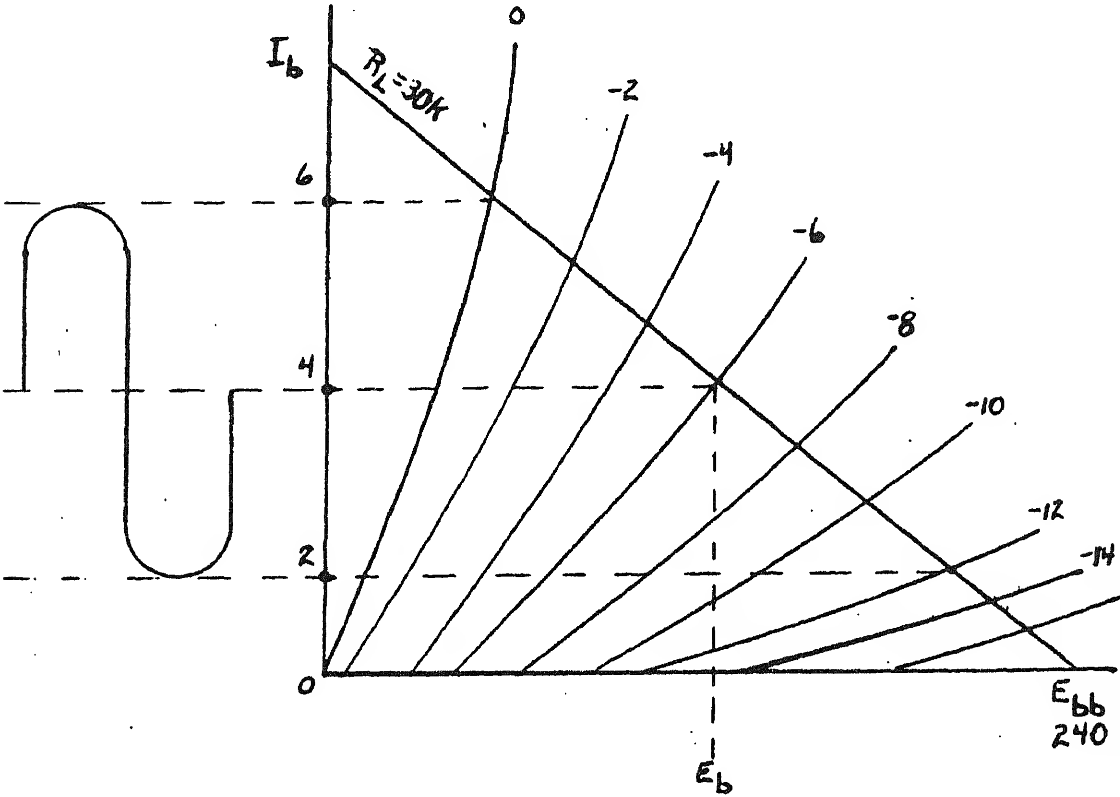


a. 1 ma
b. 3 ma
c. 6 ma
d. 4 ma

17. Power amplifiers are normally designed to produce

   a. large signal voltage outputs.
   b. large amplitudes of a-c plate current to the load.
   c. large power dissipations in the control grid.
   d. small values of a-c power output to the load.

18. In figure 2, calculate the gain of the amplifier.



   a. 10
   b. 15
   c. 30
   d. 20

19. What is the minimum instantaneous value of plate voltage, if i_p is 2 ma, R_L is 40k, and static plate voltage is 165 volts?

   a. 80 volts.
   b. 85 volts.
   c. 125 volts.
   d. 245 volts.

______b. Decrease plate-to-control grid coupling.
______c. Increase plate-to-control grid feedback.
______d. Suppress secondary emmission.

21. Which interelectrode capacity shunts out the resistive load at higher frequencies?

______a. Control grid to palte.
______b. Plate to cathode.
______c. Control grid to cathode.
______d. Cathode to heater.

22. The four electrodes contained in the tetrode are

______a. cathode, screen grid, beam-forming electrodes, and plate.
______b. cathode, control grid, suppressor grid, and plate
______c. cathode, control grid, plate, and screen grid.
______d. cathode, control grid, beam-forming electrodes, and plate.

23. For proper operation of a tetrode as a voltage amplifier, it is necessary that the

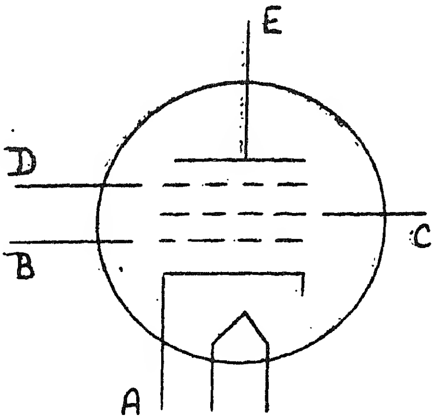
______a. plate voltage always be less than the screen voltage.
______b. screen-grid voltage always exceed the plate voltage.
______c. screen-grid voltage be negative with respect to the cathode.
______d. plate voltage always exceed the screen voltage.

24. What was the primary purpose in the development of the pentode?

______a. To decrease plate-to-control grid coupling.
______b. To prevent secondary emission.
______c. To overcome the negative resistance region common to tetrodes.
______d. To produce a tube with transconductance comparable to that of tetrodes.

25. What two electrodes of the tube shown in figure 2 are often connected together?

_____a. C and E.
_____b. A and D.
_____c. B and D.
_____d. A and B.



26. The electrodes contained in a beam-power tube are

_____a. cathode, control grid, suppressor grid, beam-forming electrodes, and plate.
_____b. cathode, control grid, screen grid, suppressor grid, and plate.
_____c. cathode, screen grid, beam-forming electrodes, and plate.
_____d. cathode, control grid, screen grid, beam-forming electrodes, and plate.

27. The effects of secondary emission in beam-power tubes are reduced because

_____a. beam-forming plates repel secondary electrons back to the plate.
_____b. primary electrons are slowed down by the screen grid.
_____c. the space charge formed between the screen and plate repels electrons back to their source.
_____d. most of the secondary electrons are attracted by the beam-forming electrodes.

ASSIGNMENT SHEET 5.5.1A
FEEDBACK AMPLIFIERS

INTRODUCTION:

This assignment provides exercises and questions which relate directly to the learning objectives. Information which is not directly available from your text is provided in the Student Information section.

LESSON TOPIC LEARNING OBJECTIVES:

5.5.1 Given statements concerning the advantages of negative feedback amplifiers compared to non-feedback amplifiers, select the correct statement(s).

5.5.2 Given a list of terms and a list of definitions, match each term to its definition.

A. Positive feedback
B. Negative feedback
C. Return difference
D. Open loop gain
E. Voltage feedback
F. Current feedback
G. Closed loop gain
H. Feedback ratio

5.5.3 Given a schematic diagram of an amplifier and statements concerning the type of feedback in that amplifier, select the correct statement(s).

5.5.4 Given a signal flow graph of a feedback amplifier, derive an expression for the output quantity (voltage or current).

5.5.5 Given statements concerning the derivation of the general feedback equations, select the correct statement(s).

5.5.6 Given the open loop gain of an amplifier, the percent of feedback and the formula sheet, calculate the closed loop gain.

5.5.7 Given the open and closed loop gains of an amplifier, and the formula sheet, calculate the % of feedback.

5.5.8 Given a schematic diagram of a transistor amplifier employing negative feedback, the circuit component values, the open loop gain of the amplifier and the formula sheet, compute the closed loop gain (A_f).

5.5.9 Given statements concerning the effects of negative current feedback on the input and output impedances of the amplifier, select the correct statement(s).

5.5.10 Given statements concerning the effects of negative voltage feedback on the input and output impedances of the amplifier, select the correct statement(s).

5.5.11 Given statements concerning the distortion in feedback amplifiers, select the correct statement(s).

5.5.12 Given statements or drawings comparing gain and bandwidth in feedback amplifiers, select the correct statement(s) or drawing.

5.5.13 Given statements or Nyquist plots concerning the gain stability of feedback amplifiers, select the correct statement(s) or Nyquist plot.

5.5.14 Given statements concerning vacuum tube feedback amplifiers select the correct statement(s).

STUDY ASSIGNMENT:

Text:

Read 1. Boylestad and Naselsky, Electronic Devices and Circuit Theory, 3rd Ed., 1982, Ch.17, pp 638-658.

Complete: Student Activity Guide 5.5.1S

STUDY QUESTIONS:

1. Would the feedback principles in this lesson apply to mechanica and electromechanical systems?

2. What would capacitance, inductance and resistance be analogous to in a mechanical device?

3. In this lesson we have discussed ideal situations (e.g., "RC" coupled amplifiers). In reality all amplifiers have inductive elements. How would inductive components effect frequency response and stability.

4. A vacuum tube stage with negative feedback is capable of amplifying a frequency at which an associated lead becomes an electrical half-wave length. What is a possible consequence of this situation.

Complete: Student Activity Guide 5.5.1S.

HOMEWORK QUESTIONS AND PROBLEMS

1. What are the general definitions of "open loop" and "closed loop" gain?

2. Write the definition of "feedback ratio" and express it mathmat cally as a gain.

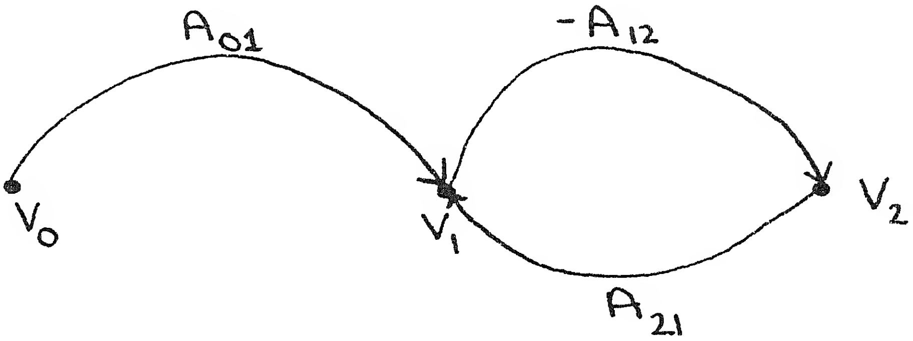
3. What is the "return difference"? (Express in your own words or mathematically).

4. What is (1) voltage feedback and (2) current feedback?

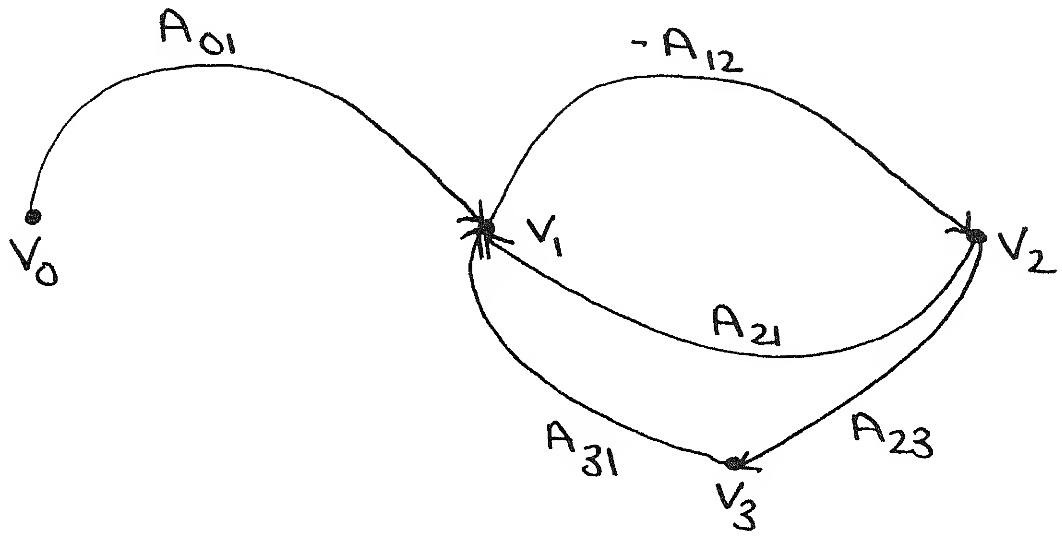
Draw block diagrams which represent; (1) shunt voltage feedback and (2) series voltage feedback.

Draw block diagrams which represent; (1) series current feedback and (2)shunt current feedback.

Derive the expression which describes V_2 in the signal flow graph below.



8. Using a reduction technique, eliminate node V_3 and write the resulting equation set.

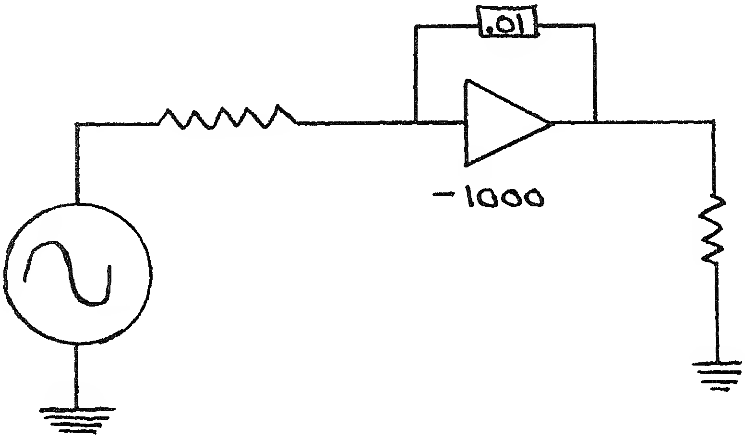


. Given an amplifier with an open loop gain of 1000 and 0.1% feedback calculate the factor by which distortion will be reduced.

0. What characteristic of feedback amplifiers makes them useful in measurement devices, such as electronic voltmeters?

1. Calculate the new f_2 point of the amplifier shown below.

$f_2 = 10^6\ H_z$, $f_{2f} = ?$



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